SCIENCE

DECEMBER 29, 1950

KENNETIC INQUIRY
ARTHUR F. BENTLEY

TECHNICAL PAPERS

BOOK REVIEWS

NEWS AND NOTES
REPORTS OF MEETINGS OF THE GENETICS SOCIETY, BOTANICAL SOCIETY, AND AMERICAN PHYSIOLOGICAL SOCIETY

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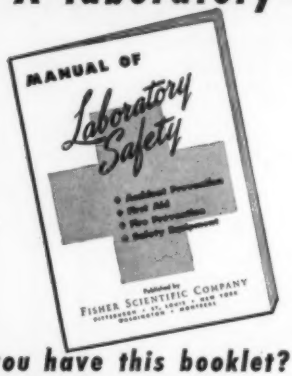

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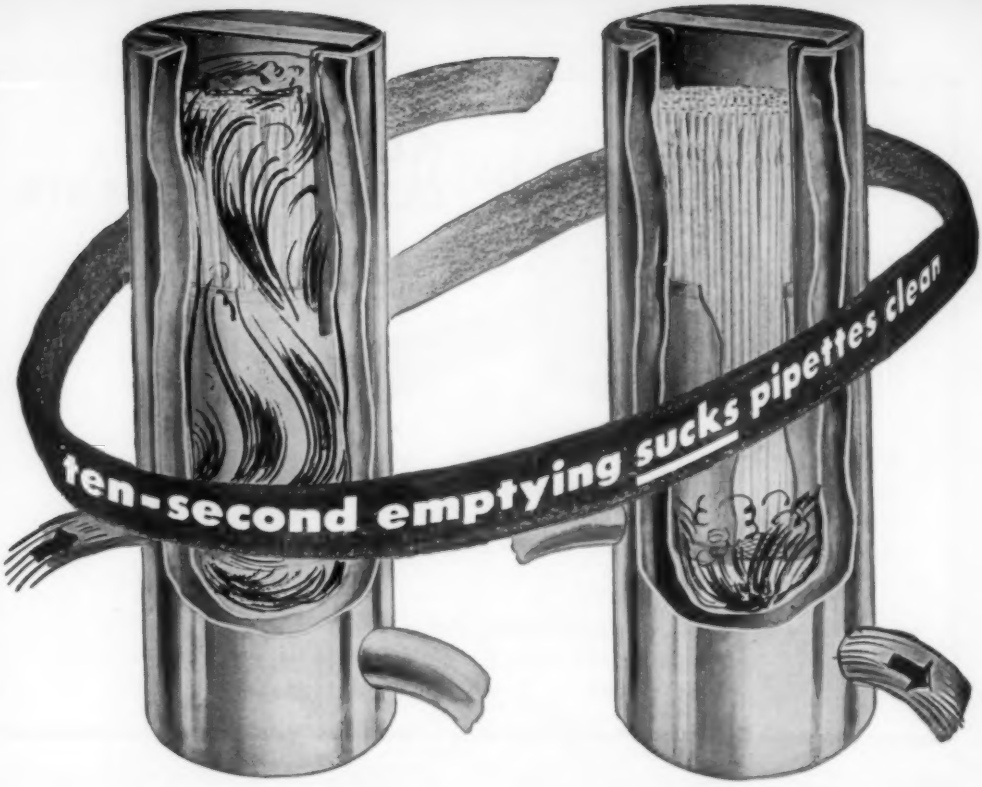
SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

All correspondence should be sent to SCIENCE, 1515 Massachusetts Ave., N. W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.

Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50.

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription rates on request.



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Kennetic Inquiry

Arthur F. Bentley
Paoli, Indiana

KENNETIC INQUIRY is a name proposed for organized investigation into the problem of human knowings and knowns, where this is so conducted that the full range of subject matters—all the knowings and all the knowns—form a common field. Such inquiry is to be undertaken under express postulation, and without specific allegation or assurance of ultimate factual status. The postulation deals with concrete instances of knowings and knowns instead of with purported faculties, powers, or realities; and under it every specific instance of a knowing is taken along with its specific known as a single *transaction* in the field. It abandons, root, branch, and fruit, the conventional severance of detachable knowers from detachable knowns. To it the word "epistemological" rates as a historical curiosity, stripped of all pretense to authority in research, and ripe only for the museum. The words "philosophical" and "metaphysical" become similarly irrelevant to our inquiry: as irrelevant as they are in physical laboratories today when actual research is in progress. Even the word "knowledge" itself is, at least for the time being, discarded, since it is steeped in vagueness, and unable to qualify technically as purveyor of determinable fact. The words "knowing" and "known" remain, however, usable, if properly provided with plural forms, and thus made able to stand for concrete instances of organic-environmental action in behavioral space and time.

Thus organized, knowings and knowns together become events in process in a cosmos, system, or field of fact, such as postulation projects and anticipates. The inquiry is then on the way, or believes itself on the way, toward becoming science. It is science in the making if, by science, is understood a procedure of observation and postulation, with all observation recognizing that it takes place under postulation, and with all postulation recognizing that it arises out of observation; and if freedom for inquiry is secured through the smashing of the old blockades so long maintained under the dominance of inadequate speech forms of barbaric origin and overripe habituation, peculiarly those proclaiming purportedly particulate sense-data.

Although the name "kennetic" has not heretofore been in use, inquiry along these suggested lines has already been undertaken, and report thereon has been made, in a book *Knowing and the Known* (*22*) by John Dewey and the present writer. To form the name "kennetic," the Scottish "ken" or "kenning" has been preferred to any word in the groups centering around "cognition," "gnosis," or "epistemology," since the latter have long since become fixated beyond recall in implications hostile to present purposes. "Ken" has a further advantage over these other roots in recalling the early Teutonic "can," which signified the activity of knowing, inclusive of "know-how" and of "be able." Using "kennetic," we may, with minimum risk of distortion, deal with active knowings as found among men who are known phases of a cosmos, which is itself in process of being known.

We here proceed to take men as in nature, to take their behaviors of whatever kind as "natural," and to take all their knowings as naturally behavioral, along with their other activities. We then strive to discover what observation may yield under the employment of such new namings as we may attain when freed from the interference of the old hostile terminologies.

The Kennetic Procedure

Kennetic inquiry, as already indicated, omits from its proceedings all facultative action of "minds" or otherwise individuated "knowers" on the side of the knowings, and all dogmatically proclaimed or otherwise individuated "ultimate reals" on the side of the knowns. I have never myself made observation of any such "pure knowers" or "pure reals;" I know no one who has; and I believe no claim to such observation has ever yet been made in a way to conform with modern scientific standards free from linguistic hypnosis. I assert that *it is easier literally to observe—to see—man-in-process with environs,* and to see

this full process as one transaction, than *it can possibly be literally to observe a "soul," a "spirit," or a psychic "mind"* (this last, a lineal descendant from the two others), or to see a "thing" as a "real" substratum apart from all our knowing and from conditioning thereby. What we find to observe under our postulation is the organism and its environs in natural presence and process together, linguistically still unfractured, or otherwise schizophrenic. Permitting observation to run free within its framework of postulation, and putting all the concentrated attention we can behind it, we secure reports on the unfractured knowing-known events. All such observation and such reports and such events-reported we style *trans*actional, in contrast with the *inter*actional reports obtained under mechanistic inquiry, and with the *self*actional reports under conventionally "psychic" presumptions. In so doing we require the "selves" and the "mechanisms," equally with the "transactions," to present themselves in postulatory form, free from pretense to underlying authoritative status. We shall adopt the word "behavioral"[1] to apply to those events involving organisms and environs which, as events, are not technically physiological or physical, nor directly covered in physiological or physical inquiry. To repeat: All behavioral events are by postulation transactions; all knowings and knowns as subject matters of inquiry belong among transactional behaviors.

Before undertaking to locate the knowings and the knowns definitely among the behaviors, let us briefly characterize the setting of the behaviors themselves as *naturally* viewed within the vastly wider field of all that is "known-to-modern-science."[2] Many differences in viewpoints as to the range of scientific inquiry are still offered us, and many different classifications of the sciences are given. We need here give attention solely to the three great technical fields recognized as basic under all classifications, and perhaps best styled Physical, Physiological, and Behavioral (where Psychological may be used as a possible alternative for the third, if strongly preferred). We treat the distinctions as those of subject matters of inquiry-in-growth (i.e., of science) and not in the older way as marking off, or resting on any assured differences in the "kinds" of "materials" that "exist."[3] It is indeed true that "physiological" and "behavioral" belong alike under "biological" when this is brought into contrast with the "physical," since they both have to do with the organic. But under present-day observation, and in the status of current inquiry and for it only, the *differentiation* of *techniques* between physiological and behavioral research cuts as deep as that between physical and physiological, and this should be technically recognized in all appraisal as of today.[4] Physical research cannot adequately advance its own technical form of description and report across the full physiological field, nor can technical physiological research in the general case be advanced to portray the behavioral field. The "languages" of report remain for the present noninterchangeable. No examination of brain or nerves or of muscle or viscera can report that "an election was held," nor even that "a cow was seen." The central cores of the three great regions are natural; the bands of transitional vagueness between them are to be taken as natural; the inquiry into them is natural. But for present-day guidance with respect to the knowings of the knowns and to the knowns as undergoing knowing, the technical differentiation as above set forth remains in effect.

The Behavioral Background

As between physiological and behavioral subject matters, the differentiation can be stated in terms of a comparative directness of process in the former, which shows itself in contrast with a certain typical indirectness in the latter (*22*, Chap. VI). Soon after Jacques Loeb at the beginning of this century published his—at that time world-exciting—reports on dominant physical processes within and across the skins of organisms (*28*), H. S. Jennings (*26*) noted a characteristic in low organisms different from that

[1] Anyone who prefers "psychological" may substitute it for "behavioral," provided he holds it to the given postulation, and adequately rejects the introduction of every form of disconnected "psyche." Those who prefer the word "cultural" would find it necessary to make that word expressly include the full range of the "psychological."

[2] An appraisal of the organization of scientific knowing with common-sense knowing will be found in Chapter X of the book referred to (*22*). Other recent papers by John Dewey make further development. A recent comment by E. U. Condon, in which he notes "the doubtful speculation which has characterized most of the philosophic absorptions of modern science," speaks of Dewey in the following terms: "One of the rare exceptions, one who has in a significant and profound way understood and used both science and the scientific method is John Dewey. He points out clearly that the growth of rational thought processes may be considered as a response to the biological necessity of adaptation to the environment. Its ultimate function, he says, is that of 'prospective control of the conditions of the environment.' It follows then that 'the function of intelligence is not that of copying the objects of the environment, but rather of taking account of the way in which more effective and more profitable relations with these objects may be established in the future'" (*19*).

[3] The word "exist" occurs in two other passages in this paper but there, as here, it is set off by quotation marks so as not to involve the writer in any claims conventionally made with respect to its range of application. If here brought into the discussion, the word would be treated transactionally within the range of designational behaviors. Signalings are too immediate, vivid, and hard-hitting to pause for existential reference, whereas symbolings have passed beyond the need for it and are even beginning to overcome the desire. (For this terminology, see the section on "Specific Positions Attained.")

[4] For a strong warning against "biologism," see Bertalanffy (*10*).

of any immediate direct physical or chemical excitation and reaction. This was found in the sea urchin, for example, when an enemy cast a shadow, and the organism moved to evade, not the shadow itself, but the on-coming, hostile shadow-caster. The present investigators, reporting in *Knowing and the Known* (*22*), have employed the word "sign" to name this technically characteristic "indirectness," as it is found across the entire behavioral field. They chose this word, not so much despite its enormous variety of current applications, as perhaps on account of them, and because none of these applications has succeeded in ruling the field in which dozens of applications are needed to work in harness. The range of "sign," understood *always* as *trans*actional sign-process, was made coincident with the range most generally of behavior itself. This was to make, in effect, sign-actings (which include sign-knowings) the characteristic, technical process in the behavioral field, as distinct from the physiological and, of course, also from the physical processes.

Within the range of sign, the word "signal" was chosen to name the underlying sensori-perceptive level; the word "designation" for the next higher evolutionary level—namely, that of linguistic sign operation; and the word "symboling" for a still higher range in the evolutionary sense, to which specific differentiation was given—namely, that of mathematics, inclusive of a comparatively small, but very important, part of modern symbolic logic that is itself rigorously mathematical, rather than a still-confused survival from the older logical attitudes.[5]

The words "know" and "known" are applied in current writing at almost any point across this range of behavior, from protozoa to the purest of pure mathematics. An insect is said to know its way around, and a mathematician (it is said), his technical business. Without objecting to other uses or attempting to set up a program of naming for others, attention here will be centered closely on the range of knowings that occur in the central regions, those of designation. This knowing is by naming,[6] and its implications are of the general type "knowing-to-exist." Common procedures in these regions are of the type that seem all the more dogmatically satisfied as to *what* they assert to "exist," the less assured they are as to what is meant by the *exist* portion of their assertion.

The word "signal" was adopted for the lowest stratum of behaviors largely because of Pavlov's increasing employment of it as his skill and breadth of vision increased (*24, 31, 32*). It is used to cover the entire complex of perceivings, inclusive of the sensory, the locomotive, and the manipulative. It covers them as action in living organisms. It covers them—and this must be continually reiterated—transactionally and not otherwise. It presents organisms and environs in process in system. It does not have to do with something organic or superorganic taken on its own. It permits no such fictional "third" item as a "percept" of the kind one finds still accepted in many current texts, despite William James' brilliant identification and rejection of such "intervening thirds" fifty years ago (*25*). If a dog's bark scares a rabbit, the signal as here viewed is neither a bark in a world of its own, nor is it a dog as such, nor is it a specialized process of rabbit's nerve and brain, but always an aspect or phase of the situation seen in full.

The word "designation" is used as the name for the next higher level of behaviors. It would be better if we could speak always, as is here done occasionally, of "name" directly. "Designation" is substituted only because "name" is still so desperately involved conventionally with presumptive, external, static "things named"—the kind out of which word magic grows—that almost inevitably conveyance of meaning is distorted or destroyed. Designations are subdivided into cue, characterization, and specification, as stages in evolutionary growth; the first of these still in process of emerging from signal behavior; the second, comprising ordinary common-sense naming; the third, demanding ever-increased accuracy and, at its highest level, representing modern science itself—not as static, but as living growth, and with the old expectant certainties gone for good. This great expansion of designation not only arises out of signal, but operates, no matter what slips and falls it has by the wayside, to increase the efficiency of signal. This can be vividly shown under transactional postulation, although under the traditional constructions it is only partially and crudely apparent. In the old form observation breaks into fragments that cannot well be patched together again. In the new form, organisms-environs, know-

[5] Fifty years ago a typical classification of the behavioral (psychological) was into sense, intellect, and will—all "faculties." Josiah Royce's sensitivity, docility, and initiative, covering physical contacts, social setting, and individual going-power, might have brought a great advance, if factually developed (*33*). Present-day psychologists' organizations are all, or almost all, "capacitative"—that is to say, merely weakened forms of the "facultative." Our proposed distribution into signaling, designating, and symboling is, we hope, fully freed of the capacitative. In the ordinary conventional organization of behavioral subject-object, where "subject" appears we are to understand "environed organism," and, where "object" appears, "known-named-environs." Lacking, however, in the present exhibit is treatment of emotional events, which, from the crudest to the most refined, are handled by assigning all direct pain components and comparably direct "liking" components to physiological inquiry, stripping out the blurred knowing-naming effects for transactional study, and thus readying oneself for further inquiry into the unclear physiological-behavioral marginal regions.

[6] For a single instance of temporarily widened application of the word "know," see part (*g*) of the section on "Specific Positions Attained." For the word "exist," see footnote 3.

ings-knowns, namings-nameds, can be seen in operation and studied without putative knowers or putative *reals* behind them as guarantors or guarantees.

Symbolings evolve out of designatings and operate to increase the efficiency of designatings, much as the latter evolve out of signalings and work to increase the efficiency of signalings. The symbolings have learned in long experience that, for best results, they must forfeit the right to use their own components as names. This forfeiture is no loss; it strips the symbolings down for action. The surviving logics of the past and their reconstructions of today, including most of symbolic logic, still operate under a confusion of symbolings with designatings and even with signalings as well. The struggle, dating mainly from Frege and Russell, to put "logical foundations" under mathematics without seeking any foundations for the reliability of the "logic" relied upon, makes the confusion all the worse. Under the transactional approach a great simplification occurs, with exactness of symbol coming definitely and explicitly to the aid of accuracy of specification.

A Reminder

Let us summarize with respect to observation of behaviors in a scientifically transactional background, within which background, in turn, definite examination of knowings and knowns may proceed. We accept the cosmos as before us in knowings, and at the same time we accept all our knowings as its outgrowth. We regard this cosmos as no better assured in our knowings of it than our knowings are assured by reference to it. We are satisfield with this basis for our research. The cosmos is our realm of fact, where "fact" requires both knowings and knowns, but makes no claim to be either of them by itself, whether today or in extrapolation into the future. Darwin brought first animal life, and then human life, under evolution called natural. Driblets of behavioral interpretation have followed his course, but little more. Efforts are here being made to bring knowings-knowns, as themselves behaviors, into system with the rest of fact in a factual cosmos. They are not in system now. The psychologists toss all such issues to the "dogs of epistemology" they seem to find whining under their banquet table. The epistemologists officiate proudly at a high altar of their own persuasion.

Specific Positions Attained

Kennetic inquiry is still regrettably compelled to spend a good part of its time in delivering itself from old philosophical-linguistic bondage. It has, however, already acquired positively a number of footholds that it regards as safe for future use. However bizarre at first sight some of the reports thereby secured may seem, they will as a body, we believe, establish their reasonableness as acquaintance grows.

For this outcome, however, free development of the extensions and durations of behavioral events must be permitted in behavioral, rather than in Newtonian, forms. To postulate events outside spatial and temporal characteristics altogether, as was the older "mentalist" procedure, would be absurd today. Newtonian clock ticks and foot rules, however, are far from sufficient. When physicists needed greater freedom in this respect, they took it; but even adjustments under Einsteinian relativity will not alone suffice for our needs, nor are the various suggestions of recent physiologies adequate to reach across the behavioral field (*8*). Behavioral *pasts* and *futures*—histories and goals, habits and purposings—are before us descriptively in behavioral *presents*. Descriptively factual knowings-knowns hold fars and nears together under their own specializations of action. Without at least the beginnings of appreciation for this possible need in behavioral inquiry—without, at least, tolerance for experiment under it—grasp of the following positions will not be gained.

a) Word-meaning and word-embodying are not separates but occur together as one behavioral transaction. No locus in the cosmos can be found either for verbal "meaning" by itself, or for verbal "embodiment" held in separation. On the one hand, word-meanings as severed from man's linguistic activity are not observable, nor are they attainable as subject matters of independent inquiry, despite all the reams that have been written purportedly about them. On the other hand, sounds and graphs apart from their meaningful appearance as man's living activity are not "words" at all for anything beyond a surface inquiry. Physics and physiology are, of course, justified in their special inquiries into their respective aspects of verbal activity, but as aspects only. To use the ancient academic labeling, what they offer is of the character of anatomy and is not an analysis of the full event. For adequate behavioral analysis a full and fair field must be open.

b) More broadly inspected, no field of events identifiable as "language" can be accurately established and brought separately under inquiry in severance from another field alongside known as the "meanings" of language. Without life-in-process neither language nor linguistic meanings can survive any more than could other behavioral events, of whatever kind.

c) In the region of designations the namings and the knowings are one process, not two. Where the naming is taken transactionally at its level of behavioral advance, it itself is the behavioral knowing. Knowing through naming is a phase of human organism-in-action. In organism-in-action the know-

ing is the naming; so postulated; so observed; so investigated.

d) Once able to see word-meaning and naming-knowing as living processes of organism-in-environs, we may next advance to observation of the knowing and the known as transactionally comprised in common event. An organism, a rock, and a tree remain before us as heretofore, subject to such physical or physiological inquiry as we may wish. Insofar, the scientific situation remains unchanged. But when rock flies and dog dodges and tree is evaded in flight, the situation becomes one in which subject matters are on a further level of complexity. Here it is but crude and imperfect presentation, an affair of casual, practical report rather than of scientific procedure, when rock and dog and tree are taken as separates, and when independent initiatives or resistances are attributed to any or all of them separately in the style of the older days, when "actualities" were presumably certified to the scientist as "given" to him in advance of his inquiry. Physicists faced a *similar* transformation in the case of the electron. To say today that the electron is an "entity" known to be such on its own, outside of and apart from the processes of its being known, would be to misrepresent modern scientific report. The electron is "known" under specialized knowings, and in highly specialized technical manners. The electron accepted in physical research is one that "works," not one that claims "reality;" it is dealt with, this is to say, as fact within the frame of existing research, not as assured for eternity. The gene in physiology more and more comes to occupy a similar position (*23*).

e) What is the case for the knowing-known is the case also for the naming-named. We have a single event such that without both phases—both the namings and the nameds—we would have no event at all. What here most seriously interferes with full technical observation is the old set of verbal fixations which sunder name, named, and namer. The evil of reliance upon severed name, out of organized contact with namer and named, is illustrated, perhaps at its historical worst, in many of the procedures of professional logics today.

f) These steps lead to a radical outcome with respect to *what* it is that is *named* by a naming, and so *known* linguistically, within an event of naming-knowing. This "what" no longer enters as if it were a "thing" outside the range of behavioral activity. Instead, "the named" is, in the primary case, itself a behavioral transaction: a signaling or perceiving that requires the joint action of its two presumptive "ends"—roughly, the intradermal and the extradermal—if it is to have any "middle" of factuality at all. This "what" that is named, therefore, neither rests upon some demand made by a "thing" upon an "organism;" nor does it enter as the determination of an "outer" thing by an "organism acting *solo*." The designational processes of organism-environs grasp the underlying signaling processes and bring them into increased behavioral organization. We not only say that a knowing without its known, or a known without its knowing, is an incoherence, but that a knowing-in-naming that pretends to know and name something outside of, or beyond, all signaling—or other organic-environmental contact—is equally incoherence. The known-in-naming is primarily what is already being perceived or is otherwise in transactional process.

g) Even more radical may seem a further assertion, again one to be taken strictly under transactional postulation. It is that the characteristic behavioral process is the process of knowing. Knowing—the naturalistic knowing-contact between organism and environs—is that which must receive basic examination and expression the moment the effectiveness of physiological techniques has been left behind, and the behavioral field has been entered. Its study constitutes the primary behavioral science. Knowing is not some wonder perched on top of organic life; it happens as process in and of the world; it is to behavioral science what radiation and gravitation are to physics, and what blood circulation and neural transmission are to physiology.

In this statement we are temporarily changing our form of expression from the technical manner established above, where "sign" was made the general name for behavioral process, and in which "knowing," as a special form of "signing," was limited to the range of "knowings-by-naming." The present passage is the only one in this paper in which this deviation occurs.[7] The deviation is made deliberately: first, because current uses make the word "knowing" run loosely and irregularly, as previously indicated, over almost all phases of behavioral organic-environmental contact, from the most primitive to the most subtly mathematical; and, second, because these same current uses subordinate "knowing" in one way or another to almost every other manner of psychological inquiry. Given this conventional looseness of expression and neglect of fact, which is found as much in professional psychology as in common speech, we accept it for one moment in order to secure the impressionistic report that is lacking at first view under the technical statement in terms of "sign."

In this background of expression, then, the knowing contact is the typically behavioral process; it is what must be inquired into first, instead of being

[7] See footnote 6.

evaded and slurred. For such inquiry it must above all things be brought fully into the "natural" frame of scientific observation. Here it is that kennetic inquiry brings the situation out into the light, and literally lays it on the laboratory table for detailed examination. In curt expression we may say, if we wish: "World flows, Life grows, Behavior knows, yet with the knowings and the knowns always components of the flow and of the growth." Most generally, then, the behavioral contact points are know-points in differentiation from physical and physiological contact-points. In kennetic inquiry, under the terminology of "sign," the crude particulate reports are passed over, on the one hand, and the wide sweeping generalizations are passed over, on the other. Transactional presentation is secured as observation gains strength. Translations into "minds," whether of moron or of mage, cease to enter. Use of the techniques of other sciences can be made without forced subordination or pretense of dominance—all of which means that the prospect improves for inquiry and report of the type we today call scientific.

With respect to the above positions (*a*) to (*g*), we may recall the various freedoms insisted upon for inquiry at one or another stage of the discussion. These freedoms are indeed at times as much in demand by physiologists as they ever are by behavioral investigators, since the best physics may at times constrict physiological progress, just as the best physiology may at times constrict behavioral; though, of course, in the latter case, protection against the old "psychical" and "mentalist" fixations is the primary need. The freedoms required are: Freedom of postulation; freedom of observation under postulation; freedom from conventional speech-forms insistently surviving from prehistoric cultures; freedom for linguistic, as well as for laboratory, experimentation; and, finally, freedom for the establishment of new systems of nomenclature in the open daylight of inquiry.

A general theory of language should become practicable in this framework, perhaps one such as John Dewey has forecast in the preface to his *Logic* (*21*). No such presentation exists. What we have, instead, is ever-renewed divagation about minds and things, all fictional, with a fictional "language" as hare to both hounds. Leonard Bloomfield's linguistic study (*11*) is probably the only work to be mentioned as differentiated from the old line, and his construction was hampered by his use of a comparatively early form of psychological behavior*ism*, something not here employed in any phase.

Status with Respect to Modern Science

The above program of observation and interpretation is not one of speedy recent development, but instead one of slow growth. It is definitely not in favor with—often not even in the field of vision of—metaphysics or other standardizations of the traditional psychological-philosophical terminologies. John Dewey laid the foundation for it in his famous essay "The Reflex Arc Concept in Psychology" in 1896 (*20*)[8] and has carried it forward through studies in almost all lines of cultural development, culminating in his *Logic, the Theory of Inquiry* (*21*). The present writer approached it in his study of group pressures in *The Process of Government* in 1908 (*4*), an inquiry much wider in scope than any study of pressure groups, the "discovery" of which is occasionally attributed to, though emphatically not claimed by, him; and he followed it later with studies of cross-sectional process in society (*5*), types of linguistic coherence in society (*6*), and communicational psychology (*7, 8*). Probably the best sociological construction undertaken from this direction is that of George Lundberg (*30*). In psychology the earliest and most important effort to see perceptions in terms of interactions between organisms and environs was that of J. R. Kantor (*27*). The ecologies are well known in all biological lines. Specialized cultural inquiries have in many cases almost reached the transactional form, though without, in any case that I am aware of, having made the necessary generalized formulation.

The greatest strength of the transactional approach at the present time is given it by the advances of physics following the initiative of Einstein, as this rested upon the observation of Faraday and its mathematical presentation by Clerk-Maxwell (*22*, Chap. IV). Newton had achieved the construction of the interactional in its region of greatest usefulness. In the last generation, in place of the interactional, physics has secured envisionments of particle as wave, of mass as energy, and of gravitation as conformation of space-time. All these changes involve widened observation and are transactional in their orientation in the sense of that term as here used. The present procedure falls into line, though at a proper respectful distance, with Einstein's long-concentrated effort to secure a unified field theory for physics.[9] Any physical field theory of most general scope will, we believe, when once soundly secured, show itself to be

[8] At the time of the celebration of the fiftieth anniversary of the *Psychological Review*, this paper was judged by a vote of several hundred leading American psychologists to be the most important paper ever published in that journal. Even yet its values are only partially realized.

[9] Although the word "field" has repeatedly appeared in this paper, its use has been casual, and it has nowhere been specifically adopted, despite its apparent superficial advantages. This is partly because certain problems as to its application are not yet standardized by physics, but more because the word has been so widely abused by overly optimistic appropriators in other than physical regions. On this point see a discussion by Ivan D. London (*29*).

a process of knowing, as clearly as it shows itself to be a system of the known. The impress of the physical knowing will be upon the physically known, and the status of each will depend upon that of the other. In this case the need of a kennetic theory on the knowing side, as correlate to the field theory on the side of the known, will make itself strongly felt. Einstein's personal attitude, as is well enough known, will not tolerate anything comparable to kennetic theory on the side of the knowing, but the observation of Bohr, and of others, is clearly in line for it. Einstein, amidst the efflorescence of German philosophical terminology—the most resplendent in the world—maintains, largely in the Kantian tradition, all the ancient self-actional treatments, inclusive of the wholly redundant, entitatively personalized know*er*, at the very time that he has been the greatest of all leaders in overcoming the rigidities of the old "knowns" by expelling that sort of reification from the physical range. Bridgman, who has been the world leader in interpreting Einstein's work as human progress (*14*), holds in his latest discussion that the traditional metaphysical bias in Einstein is now at work where it may be positively hurtful to the results Einstein secures. Bridgman's comment is that "in Einstein's yearning for absolute information and meaning it seems . . . that the ghosts of Newton's absolute space and time are walking again, ghosts which Einstein himself had apparently exorcised in his special theory of relativity" (*15*, p. 19); and again, more specifically, that Einstein "believes it possible to . . . sublimate . . . the point of view of the individual observer into something universal, 'public,' and 'real' " (*16*, pp. 349, 354).

Recent Transactional Approximations

Several papers have appeared in Science within the past year outlining scientific development on lines sympathetic to, and in some cases directly comparable with, kennetic treatment. Cantril, Ames, and their associates expressly accept transactional observation and construction under that name for psychology. Bertalanffy proposes regions comparably transactional for physiological inquiry. Bohr sharpens his long-maintained stress on physical complementarity as opposed to the epistemological type of "reality" toward which he, as well as Bridgman, sees Einstein still straining. Dobzansky's discussion of "basic concepts" in the genetic field sees openings for ever-greater observation and research into "system" free from patterns and methods, the enforcement of which earlier workers demand.

Bohr's paper (*12*) is supplemented by his extended contribution to the volume dealing with Einstein's philosophical ceremonies in the *Library of Living Philosophers* (*13*). Where Einstein still holds to man-the-predictor as the test of whatever "element of physical reality" there is to be found, Bohr asserts the rights of verified observations as they come (the issue of "indeterminacy" being central to this discussion); he permits the contrasts of observation to stand undisturbed within the system of the known, asserting that in them "we have to do with equally essential aspects of all well-defined knowledge about the objects;" he finds here growth, not confusion; and he insists that "causality" will not be lost, but will in the end be better understood. Outstanding is his demand for the clarification of the many ambiguous terms, ambiguously standard to all the philosophico-scientificoid rummagings. Above all, the word "phenomenon," he declares, should be confined to "observations obtained under specified circumstances including an account of the whole experiment." Such a demand runs side by side with Bridgman's requirement (*14*) that the "operations" involved in any naming be made known, and with our present insistence that "observation under postulation" should be companion to "postulation derived from observation." With strictly practical intent Bohr quotes the ancient saying that men are both actors and spectators in the drama of existence.

Bertalanffy (*9, 10*) appraises the intraintegumental organism taken as subject matter of general observation and description, and finds it inadequate as a system. He then considers a wider system of organism-plus-environment and develops its import. His attention is not directed to the specialized range of behaviors-in-environment, such as we have been discussing "transactionally" in the still more specialized case of knowings-knowns, but instead covers the underlying field of physiology in general, and covers it in such a manner that, if he so happens to wish, he could readily apply to it the word "transactional" in a sense not in conflict with that in which Clerk-Maxwell employed the word three quarters of a century ago, or with that in which we have been using it here. Bertalanffy makes his main differentiation run between "closed" and "open" systems. Most physical systems are closed systems. The organism by itself is an open system. In the technically closed system no material enters or leaves, reversibility is in most cases practicable, and an equilibrium-state in which entropy is at a maximum must ultimately be attained. In the open system, in contrast, there is a continuous flow of components from without, their flow and ratio are maintained constant, irreversibility appears in great degree, growth is characteristic, a steady-state characterized by minimum entropy-production may be approached, and, finally, when disturbance occurs, "self-regulation" operates to restore balance. The status of Bertalanffy's distinction of the physiological

from the physical is akin to our present distinction of the behavioral from the physiological in that in neither case are sharp borders set up; in neither case are "existential realities" pretended to; in each case future studies may reduce or eliminate unexplored border-areas; and, more important than all, in each the differentiation rests jointly upon the techniques of inquiry established and upon the main systems of the knowns that appear as the outcome of inquiry. Under this approach Bertalanffy anticipates that biology may advance toward being an exact science, and physics itself will have new pathways open to it. It might comparably be considered assured that, if a sound working basis for the differentiation of knowings and knowns in system is sometime attained, all branches of scientific inquiry will benefit thereby.

Dobzhansky's paper (*23*) is throughout an exhibit of advancing freedom in genetic research. A transactional attitude, though not in specific development, is seen replacing the earlier interactional stresses deriving from common speech and physical formulation. Priority of research for physics is, of course, maintained here as in the other papers mentioned, and in kennetic inquiry as well. Terminology is not developed, and interactional expression is still largely employed. But whatever components are introduced as particulate quickly reappear in broadened system. The chromosome is an organized system. The genotype (except for viruses) "is an integrated system of many kinds ('loci') of genes." The genotype is in system with the environment. The environment of the moment "is only a component of the environmental complex that determines the mutation." The development of the individual "is an orderly sequence . . . in which the genotype and the environment are involved." The geneticist's growing freedom from the patterns with which he began is manifest in all this; and it is manifest as widening interconnection of the factors, not as their mechanistic application, one to another.

In three papers under the general title "Psychology and Scientific Research" (*18*), Cantril, Ames, Hastorf, and Ittelson argue in favor of a transactional approach for psychology, adopting that name as it is established in the book *Knowing and the Known* (*22*) and believing that they are justified in anticipating revolutionary developments when psychology comes to be investigated from such a viewpoint. The solid strength behind their position lies in the work Professor Ames has carried on for more than twenty years in his laboratory at the Dartmouth Eye Institute, and as elaborated more recently in conjunction with psychologists at Princeton through the Institute for Associated Research. One of his exhibits, that of the distorted room, in viewing which ordinary perceptive processes default, has become well known through widely circulated accounts in newspapers and magazines a year or so ago. An even more startling exhibit, dealing with motion rather than with objects at rest, is that of the revolving windows, the report on which, at the present moment, is still in manuscript (*2*). A rectangular window of conventional appearance can be seen slowly revolving on its vertical axis. A trapezoidal window, comparable in size, and similarly revolving alongside, cannot be seen to revolve, and cannot even be plainly seen as a trapezoid. Persistent efforts by experimenters to see complete revolutions of the entire frame have failed. Even when a long rod touching the window is used as an aid by the observer, he makes little progress, and that little is lost by the following morning. Headaches and nausea may mark his disturbance. What the observer "sees"—or, perhaps, "seems to see," depending on what meaning one gives the word "see"—is an apparently rectangular window of changing length, oscillating at changing speeds to right and then to left in a total arc of about 100° (if degrees of arc can be injected at all in a case like this), and then returning to its starting point, just as the rectangular window completes its full observed revolution.

Professor Ames' workshops offer some fifty interrelated exhibits of persistent perceptions or, more properly, perceptual processes, that are out of agreement with the commonly accepted approaches to the physiological and behavioral interpretations of vision. We have here not simply illusion in the ordinary sense, but illusion so pronounced that doubt is cast on the apparent "actualities" or "realities" of ordinary visual report, and the need arises for an ever more rigorous inquiry into the conditions under which such observation takes place. This is closely akin to Bohr's requirement, quoted above, for the word "phenomenon": that its use in physics should be confined to "observations obtained under specified circumstances including an account of the whole experiment" (*12*). Professor Ames would hardly make as radical a statement as this. Nevertheless, in summary, he holds that perceptions as they come cannot be referred flatly to outer objects, nor to inner capacities as producers; and no more to the latter when neurologically postulated than when taken in the old slipshod form of the "psychic" (*2, 3*). Perception, to him, tends to become frankly and openly a "transaction" involving organism and environment in union, in the presentation of which both what he styles "assumption" and what he styles "purpose" or "value" must be included; namely, the past history of individual and race, and the advancing objectives of living man and group. "Prognostic directive" is a name he favors as best characterizing this perceptional

activity of the organism. He has sketched the organization of the neural processes involved, and has proceeded with patience, ingenuity, and steady attention to openings for further test. In an address to architects a few years ago (*1*) he summed up: "While in no way denying the existence of the 'external world' our disclosures apparently show that the only aspects of it man can know anything about are those aspects which are either helpful or thwarting in carrying out his purposes."

In harmony with Ames' work is that of Hoyt Sherman at Ohio State University in which unexpected abilities have been aroused in students by a drawing technique that organizes the total visual field with the muscular requirements of the procedure under way (*34*).

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Technical Papers

Prolongation of the Fertilizing Capacity of Sea-Urchin Spermatozoa by Amino Acids

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The life span of sea-urchin spermatozoa can be prolonged by addition of various agents to the sea water in which they are suspended (*1*). Hayashi (*2*) found that dilution of the sperm with seminal fluid instead of sea water extends the fertilizing capacity considerably and that the effective agent is most probably a protein. Chang (*3*) has obtained a similar effect of seminal fluid on spermatozoa of rabbits. Metz (*4*) noted that addition of hen's egg white increases the fertilizing power of starfish sperm. Wicklund (*5*) found that bovine serum albumin, trypsin, and chymotrypsin maintain very well the fertilizing power of dilute suspensions of sea-urchin spermatozoa, whereas glucose and fructose are somewhat less effective.

We have confirmed the effect of these proteins on spermatozoa of the sea urchins *Lytechinus pictus* and *Strongylocentrotus purpuratus*. In addition, we find that various amino acids give more marked extension of the functional life of the spermatozoa. The amino acids thus far tested include glycine, alanine, valine, leucine, and lysine, and all are found to be active in this regard. The peptide glutathione was also tested and found to be effective.

The tests were made with both relatively dilute (*ca.* 0.5%) and relatively concentrated (*ca.* 5%) sperm sus-

TABLE 1

EFFECT OF GLYCINE ON THE DURATION OF FERTILIZING CAPACITY OF SPERMATOZOA OF THE SEA URCHIN *Lytechinus pictus*

Sperm concentration	Age of suspension	ml of sperm used for insemination	Percentage fertilization with sperm aged in	
			0.05 *M* glycine in sea water	Sea water
0.4%	10 min	0.05	0.2	0
	"	.2	8	2
	"	.8	95	8
	20 min	.05	0	0
	"	.2	10	0
	"	.8	65	0
	4 hr	.2	10	0
	"	.8	100	0
	7 1/2 hr	.2	10	0
	"	0.8	40	0
	24 hr	2.0	25	0
5%	4 1/2 hr	0.05	100	20
	"	.1	100	70
	"	.2	95	100
	5 5/6 hr	.05	100	0.5
	"	.1	100	15
	"	.2	100	40
	6 3/4 hr	.05	100	0
	"	.1	100	0
	"	.2	100	0
	23 hr	.05	0	0
	"	.1	10	0
	"	0.2	90	0

pensions. As is well known (*6–9*), the life span of the spermatozoa in sea water decreases with increasing dilution of the suspension. The maintenance of fertilizing capacity by addition of amino acids was obtained with both concentrated and dilute suspensions, the latter exhibiting the more marked relative prolongation. The suspensions were allowed to age at room temperature (20°–22° C) in flasks on a slow shaker, or unshaken in a shallow layer in Petri dishes. The solutions were made up in sea water and adjusted to the pH of sea water. Inseminations were made with various amounts of control and treated sperm added to 5 ml of sea water containing about 400 eggs, and percentages of fertilization were determined from both membrane elevation and cleavage. In Table 1 a sample of the results obtained with glycine is presented.

The data of 12 sets of experiments with 0.05 *M* glycine consistently show a prolongation of fertilizing capacity which, for dilute suspensions, amounts to more than fifty times that of the controls. Tests with 0.01 and 0.1 *M* solutions gave less extensive prolongation than did the 0.05 *M* solutions. When glycine is added to sea water-senescent spermatozoa, there is an improvement in their fertilizing capacity, but this does not attain the value exhibited by the spermatozoa that have been in glycine from the start.

Runnström *et al.* (*10*) and Wicklund and Gustafson (*11*) found that when underripe sea-urchin eggs, which fail to fertilize or to form good membranes, are pretreated with, and inseminated in the presence of, glycine good fertilization and membrane elevation are obtained. We have confirmed this interesting discovery and find, in addition, that the effect is obtained by treatment of the sperm alone. There is, of course, a small amount of glycine carried over with the sperm, but control tests show that the presence of such small amounts during fertilization has very little, if any, effect. Also, pretreatment of the eggs with glycine gave no such improvement in fertilization or membrane elevation as is obtained by treating only the sperm and inseminating in sea water.

Sea-urchin spermatozoa that have been reversibly agglutinated by fertilizin suffer an impairment of fertilizing capacity (*12*). Treatment with glycine improves somewhat the fertilizing power of such suspensions, but it remains far below that of the controls. The results are interpretable as an effect of the glycine on a fraction of spermatozoa that had not reacted with the fertilizin. Tests were also made of the effect of glycine on the agglutination of the sperm by fertilizin. The titer of agglutination was found to be unaffected. However, the spontaneous reversal of agglutination occurred considerably (roughly three times) more rapidly. This is consistent with the increased activity that the spermatozoa exhibit in the glycine solutions, since the rate and degree of spontaneous reversal correlate with degree of activity (*12*). Determinations were also made of the liberation of antifertilizin from the sperm upon aging. This was found to occur earlier and in higher titer in sea water than in the glycine solution. The presence of the amino acid evidently opposes the dissolution of this surface constituent of the spermatozoon.

In this connection Metz (*13*) has recently found that various α-amino acids, including the ones used in these experiments, act as adjuvants for the agglutination of starfish sperm by fertilizin. It appears, then, that the action of the amino acids in maintaining fertilizing capacity may involve an effect on the antifertilizin of the sperm.

Since the spermatozoa in glycine are maintained in a state of high activity it is evident that glycine also has a metabolic effect. One possibility is that the amino acid is oxidized. However, determinations of ammonia (which is one of the products of oxidation) showed no significant production. Also tests for utilization of glycine by the sperm, by the method of Alexander *et al.* (*14*), showed no appreciable disappearance. Ammonia was also tested (at the pH of sea water) for possible action in prolonging the life span of the sperms and was found to be effective, although much less so than glycine. At 0.05 *M* it proved deleterious, but concentrations from 0.01 to 0.0005 *M* were found to be increasingly favorable. It is possible, then, that the effective agent in the action of the amino acids may be ammonia continuously produced in amounts too small to be readily detected chemically.

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Polarographic Measurement of the Oxygen Consumption of Skin *in Vivo*[1]

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Manometric measurements have shown that oxygen consumption of the skin is markedly changed by inflammatory diseases, neoplasms, hormonal influences, age, irradiation, and vesicants (*1–4*). The present study utilizes a polarographic method for estimating oxygen tension and oxygen consumption of human skin (*5, 6*). The results in normal skin are presented.

Polarographic measurement of cutaneous oxygen consumption is based on the observation that removal of oxygen supply by blanching the skin results in a rapid fall of the oxygen tension to very low levels in 1½–2 min. This is achieved by elevating the tip of an electrode, inserted intracutaneously, until enough pressure is applied to the overlying skin to force the blood out of a 5–6-mm² area (*6*). An estimate of the relative rates of the oxygen consumption of tissues can be obtained from the rate of fall of the oxygen tension.

One hundred and thirty experiments were performed within a 20-cm² area of the extensor surface of the left forearm of 3 healthy white male students. The electrodes were inserted into the skin to depths corresponding approximately to those of the epidermis and corium and into hair follicles. Control experiments were carried out on excised human skin stored for 4 days, and on the abdominal skin of an anesthetized dog after intradermal injection of 0.1 ml of 0.1 *M* sodium azide. Galvanometer readings were recorded every 15 sec throughout the experiment, following stabilization of the electrolysis current.

Elevation of the electrode tip results in a movement artifact, which consists of a partial fall of the electrolysis current. The first reading after the application of pressure was not considered in the evaluation of the experimental results because of the movement artifact.

The fall in oxygen tension in human skin, plotted against time on semilog paper, was found to approach a straight line. The oxygen consumption of normal human epidermis was significantly greater than that of normal corium in the same area. Extremely rapid oxygen uptake was found in about 30% of the experiments in which electrodes had been inserted into hair follicles. It seems possible that in these cases the tip of the electrode entered a sebaceous gland (Fig. 1).

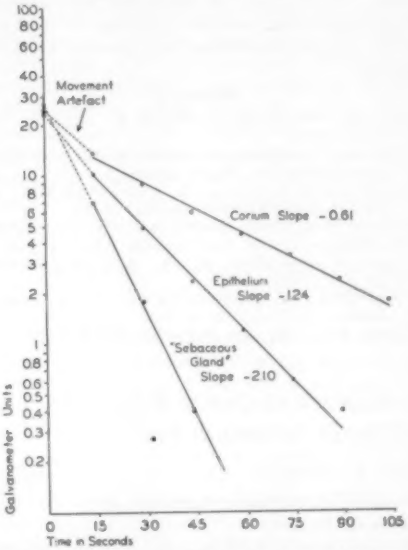

FIG. 1. Relative oxygen uptake of corium, epithelium, and "sebaceous glands" of normal human skin measured polarographically. Oxygen tension is expressed in galvanometer units.

The frequency distribution curve of the slopes obtained from the experiments on normal human skin shows 3 maxima. These correspond to the 3 levels of the skin to which the electrodes were inserted, and are related to one another in the same way as the QO_2 values reported for connective tissue, skin, and glandular tissue in manometric studies (Table 1).

Immediate repetition of the measurements in the same skin area without reinsertion of the electrode significantly decreased the oxygen consumption. This was probably a result of injury to the skin.

TABLE 1

RELATIONSHIP OF RELATIVE OXYGEN UPTAKE OF CORIUM, EPIDERMIS, AND "SEBACEOUS GLANDS" MEASURED POLAROGRAPHICALLY TO QO_2 OF HISTOLOGICALLY SIMILAR TISSUE OBTAINED BY MANOMETRIC METHODS (*1, 7*)

Region of skin	Logarithm of mean slope	$\frac{10}{\text{Slope}}$	Tissue	QO_2
Corium	−0.65	0.44	Connective tissue	0.4
Epidermis	−1.30	2.00	Skin (*1*)	2.1
"Sebaceous gland"	−2.00	10.00	Liver (7)	9.0

[1] This work was aided by a grant from the U. S. Public Health Service.

When the identical experiment was performed in excised, dead human skin, and in the intact skin of a living, anesthetized dog after the local injection of sodium azide, there was no fall in oxygen tension after the initial movement artifact. This evidence for the inability to utilize oxygen, noted in dead skin, and in living skin the cytochrome oxidase system of which had been blocked by sodium azide, bears out the usefulness of this method for the relative measurement of cutaneous oxygen consumption.

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Self-Selection of Diet in Relation to Audiogenic Seizures in Rats[1]

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It is known that some laboratory rats when subjected to sounds of high frequency exhibit convulsive behavior (*1, 2*). The pattern of such seizures is fairly uniform and consists of wild, undirected running, followed by tonic-clonic spasms and a comatose stage. Spontaneous seizures of a similar pattern have been reported in animals fed diets deficient in such substances as thiamine (*3*), pyridoxine (*4*), and magnesium (*5*). Likewise, supplementary feedings of thiamine hydrochloride have been found to render rats selectively bred for seizure susceptibility increasingly resistant to the sound-induced convulsions (*6*).

The similarity between patterns of convulsive seizures resulting from inadequate diets and those that occur under auditory stimulation has made it difficult to determine the etiology of the latter type of seizure. It occurred to us that utilization of a self-selection technique similar to that employed by Richter (7) might enable us to detect subjects in our colony whose susceptibility to sound-induced convulsions was conditioned by dietary factors. Such a technique might prove of special value in those cases lacking observable evidence of nutritional deficiency.

Sixty-five albino rats, males averaging 45 days of age at the start of the experiment, were studied. Wherever possible littermates were used, and the split-litter technique employed. Essentially the same method of auditory stimulation was employed as in previous experiments on the production of convulsions in rats (*8*).

In order to determine the incidence of audiogenic fits, the subjects were exposed to 3 min of stimulation with a heavy-duty electric bell daily for 14 days prior to the experiment proper. During this period all animals were maintained on laboratory-prepared stock diet, consisting per 1,000 g of diet of the following ingredients:

Graham flour	725 grams
Skim milk	100 "
Casein	100 "
Calcium carbonate	15 "
Sodium chloride	10 "
Butterfat	50 "

Twenty rats, selected on the basis of their degree of susceptibility to sound-induced seizures, composed the experimental group. Ten of the rats showed fits in excess of 50% of the times tested and were designated consistently susceptible animals. The remaining 10 experimental subjects had seizures less than 25% of the times tested and were considered sporadically susceptible rats. Forty-five rats constituted the control group. Of these, 15 showed the seizures consistently, 15 had sporadic fits, and 15 failed to have any seizures.

Three diets were used in the experiment proper: the stock diet referred to above, commercial Purina Dog Chow Checkers, and a self-selected diet. The latter consisted of the following:

Solutions presented in 100-ml graduated inverted bottles affixed to especially constructed living cages:

1% solution of potassium chloride
2% solution of calcium lactate
3% solution of sodium chloride
4% solution of sodium hydrogen phosphate
0.02% solution of vitamin B-1
0.02% solution of vitamin B-6
0.01% solution of calcium panothenate
0.1% solution of nicotinamide
0.5% solution of choline chloride
0.00125% solution of riboflavin
Distilled water
Olive oil
Cod liver oil

In solid form, presented in nonspillable food cups:

Dextrose
Vitamin-free casein

All the experimental animals were placed for 14 days on each of the diets in random order. Tests for susceptibility to audiogenic seizures were given for 3-min periods daily. Of the control rats, 5 animals from each of the resistant, consistently susceptible, and sporadically susceptible groups were maintained throughout the 42-day experimental period on each of the 3 diets. All controls were exposed to 3 min of auditory stimulation daily.

Daily nutritional intakes, self-selection choices, and responses to sound stimulation were recorded. Weekly fluctuations in body weight were measured.

Among the experimental animals consistently susceptible to sound-induced seizures, 2 animals failed to show the fits when placed for 14-day periods on the self-selected diet. Both these subjects were found to have atypical selections of thiamine. One of the rats averaged 2.5 mg/day, the other 4.0 mg/day, intake of thiamine hydrochloride. These amounts were in excess of the normal

[1] Aided by a grant from the Committee on Scientific Research of the American Medical Association.

requirements for animals of the age and body weight of these 2 subjects (*9*). On both the stock diet and Purina Chow these experimentals showed audiogenic seizures consistently. Of the sporadically susceptible experimentals, one animal failed to have sound-induced seizures while on the self-selected diet. This rat was found to have an average daily intake of magnesium chloride that amounted to 3 mg. Compared with the magnesium requirements of rats of the age and body weight of this subject, this amount can be considered excessive. The animals continued to show fits sporadically when placed on either stock or Purina diet. Three of the consistently susceptible controls and one of the sporadically susceptible control rats failed to have audiogenic fits during the 42 days on the self-selected diet.

In every instance the controls whose seizures were alleviated by the self-selected diet showed excessive intakes of thiamine hydrochloride. The approximate average amount of this vitamin consumed per rat per day amounted to 5.0 mg. In general, in the cases where self-selection alleviated seizure susceptibility, the rats failed to show the seizures after an average of 8 days on the diet.

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Phenyl Phenaceturate from the Decomposition of Penicillin in the Presence of Phenol

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Aqueous solutions of potassium penicillin G containing sodium citrate as buffer and phenol as a preservative may be kept under refrigeration for relatively long periods of time without undergoing serious deterioration. However, at room (25° C) or higher temperatures such solutions have been observed to deposit a colorless crystalline precipitate. This precipitate has been identified as phenyl phenaceturate.

A solution containing 31.6 g of crystalline potassium penicillin G, 2.5 g of phenol, and 2.5 g of sodium citrate in 1 liter of water was kept at 37° C. After 24 hr a slight crystalline precipitate was present and after 48 hr about 2 g of the precipitate had separated. No more appeared to be formed on longer standing at 37° C. The long needlelike crystals were collected and air-dried. They were insoluble in water, sparingly soluble in ether, readily soluble in acetone, and easily recrystallized from alcohol, mp 132°–133° C. Analysis showed the presence of 71.39% carbon, 5.85% hydrogen, and 5.49% nitrogen. Calculated values for phenyl phenaceturate ($C_{18}H_{19}NO_5$) are 71.36% carbon, 5.62% hydrogen, and 5.20% nitrogen. A sample of the compound was saponified by warming with dilute alcoholic sodium hydroxide solution. After evaporation of the alcohol and acidification of the residue with hydrochloric acid, there was present a strong odor of phenol, and phenaceturic acid crystallized from the solution. It was identified by mp 142°–143° C and mixed melting point with an authentic sample. The phenaceturic acid was also characterized by the identity of its x-ray powder diagram with that of an authentic sample.

The phenyl phenaceturate obtained from penicillin was further identified by finding that its x-ray powder diagram and infrared absorption spectrum were identical with those of a synthetic sample of phenyl phenaceturate. The synthetic sample was prepared as follows: Phosphorus tribromide, 7.1 g (0.026 mole), was added to a solution of 5.5 g (0.028 mole) of phenaceturic acid in 50 ml of dry dioxane. The resulting crystalline precipitate of 2-benzyl-4(5)-oxazalone hydrobromide (*1*) was centrifuged and washed with anhydrous ether. To the solid was added 5.3 g (0.056 mole) of phenol, and the mixture was heated at 80°–90° for 1 hr, after which it was poured into ice water. The oil that separated eventually crystallized. This was dissolved in ethyl acetate; the solution was washed with aqueous sodium bicarbonate solution, dried, and evaporated in vacuum until a crystalline precipitate separated. The product, phenyl phenaceturate, was recrystallized from alcohol—yield, 1.25 g (20%); mp 132°–133°—and mixed with the product obtained from penicillin as described above, mp 132°–133°.

It is not surprising to find derivatives of phenaceturic acid resulting from the decomposition of penicillin G (*2*), nor is it particularly surprising that the azlactone ring of penicillin is apparently opened by phenol. The azlactone ring is similarly opened by methanol, ethanol, and other alcohols, which form the corresponding esters of penicilloic acid (*3*). However, it was surprising to find that phenyl phenaceturate was formed from penicillin G and phenol in aqueous solution only when a buffer was present. In the absence of a buffer the solutions turned yellow on long standing or warming, but deposited no precipitate. Potassium phosphate, as well as sodium citrate, as described above, was effective in promoting the formation of phenyl phenaceturate in solutions containing phenol and penicillin G.

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Limitations of the "Normal" Body Weight as a Criterion of Normality[1]

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In attempting to characterize the physical or nutritional status of an individual, the gross body weight is widely used as the first criterion. "Standard" tables are available that purport to give the "normal" body weight for the individual's sex, height, and age. Most, if not all, of the tables for adults cited in American textbooks—frequently without indicating the original source of information and lacking consistency in the recommended adjustment for clothing—go back to the Medico-actuarial Mortality Investigation of 1912. These tables indicate that body weight continues to increase, on the average, even after the growth in height is completed. This trend is incorporated in the standards.

In the course of studies on ageing, carried out since 1947 at the Laboratory of Physiological Hygiene, with special emphasis on the cardiovascular system and its disturbances, we became acutely aware of the misleading nature of the height-age-weight standards. In terms of quantitative morphology a middle-aged man, retaining his relative position in the distribution of weight for men of a given height, differs markedly from his physical status in his early twenties.

TABLE 1

QUANTITATIVE CHARACTERISTICS OF FATNESS IN YOUNGER AND OLDER MEN WITH NORMAL RELATIVE BODY WEIGHT

	Younger men (N = 37)	Older men (N = 66)
Age range, years	19–25	45–55
Mean age, years	22.1	49.1
Range of relative body weight, actual, as percentage of standard weight	95.0–104.9	95.0–104.9
Mean relative body weight	100.2	100.0
Skinfolds, in mm		
Abdomen	13.7	25.3
Chest	11.4	25.4
Back	11.7	20.3
Arm	10.4	14.3
Thigh	8.1	10.2
Specific gravity*	1.079	1.056
Body fat, as percentage of body weight	9.8	21.0

* Corrected for residual air in the lungs.

Table 1 presents data on two groups of men, 19–25 and 45–55 years of age, respectively. Both groups were drawn from larger samples, restricting the selection to those individuals whose actual body weight was within ±5% of their standard weight. The mean values of the relative body weight in the two groups are very close (100.2 and 100.0, respectively). Nevertheless, the amount of body fat, determined both in terms of the thickness of the skinfolds (*1*) and estimated on the basis of specific gravity (*2, 3*), is strikingly larger in the older men. Although both groups are "normal" in respect to their body weight, they differ markedly in terms of the composition of the body.

The concept of "normal" body weight, defined actuarially, tends to obscure the profound changes taking place in the process of ageing. The latter involves not only an additive accumulation of body fat but also, very likely, replacement of some of the muscle (and other "active tissues") by fatty tissues.

It is a current practice to express the rates of physiological processes, such as the basal metabolic rate, and to prescribe pharmacological dosages in reference to the total body weight or to the body surface, the latter being estimated in turn from body weight and height. In view of the variations in the composition of the body at the same weight and the differences in the metabolic properties of muscles and the depot fat, it appears that the expression "per kg of body weight" may lead to erroneous conclusions. The vexing problems of physiologically sound reference points for the basal metabolic rate were discussed in some detail in connection with studies on prolonged starvation and nutritional rehabilitation (*4*).

[1] The data reported in this paper were obtained in the course of research aided by the Research Grants Division, U. S. Public Health Service.

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Hypotension in the Rat Following Limitation of Potassium Intake[1]

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There is an increasing amount of evidence that an adequate intake of potassium is necessary for the anatomical integrity of the myocardium and kidneys (*1, 2*). Data on the functional aspects of this relationship are scanty, however. The following experiments suggest that potassium deficiency has a profound effect on circulatory dynamics as reflected in blood pressure changes.

Four groups of Long-Evans rats (age, 45 days) were treated as follows: Group I (12 rats) received a synthetic diet in 1 g of which there was 0.1 mg of potassium. Group II (8 rats) received the same diet, but were permitted to drink a 1% solution of potassium chloride. Group III (10 rats) received a restricted amount of Purina Chow laboratory ration in an amount that allowed

[1] Preliminary report.

[2] The authors wish to express their thanks to Elizabeth Wright for her technical assistance.

the animals to grow at approximately the same rate as the rats in Group I. Those in Group IV (10 rats) were maintained on Purina Chow *ad lib.* Blood pressure readings were determined on the rats under light ether anesthesia by the microphonic method of Friedman and Freed (*3*). Readings were taken at the beginning of the study and once weekly for 9 weeks.

The rats in Group I exhibited a pronounced degree of generalized flaccidity of the skeletal musculature. Growth was restricted, their weight increasing from an initial average of 116 g to an average of 152 g after 9 weeks. Otherwise, they appeared in good physical condition. The animals in Group II, receiving supplemental potassium, were in excellent health. Their weight increased from an average of 115 g to 234 g. Those in Group III maintained approximately the same weights as Group I. The rats of Group IV grew from an average of 111 g to 346 g.

Our findings revealed that the rats maintained on the potassium-free diet (Group I) exhibited a steady decline

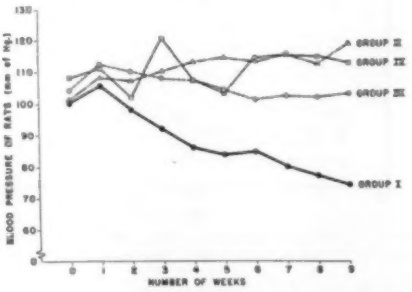

FIG. 1.

in blood pressure (Fig. 1) after the second week, from an average initial reading of 100 mm of Hg (range, 92–116 mm). At the end of the fourth week the blood pressures averaged 86 mm of Hg (range, 80–102 mm). At the end of 9 weeks the average pressure was 74 mm of Hg (range, 68–86 mm). Animals in the control groups, II, III, and IV, showed no marked deviation from normal in their pressures.

Our results indicate that rats on a diet deficient in potassium develop a profound hypotension. Other rats on an identical diet but supplied with potassium, maintain a normal blood pressure. A third group of animals on a standard diet, but partially starved to grow as slowly as those in Group I, also had a normal pressure. It would appear, therefore, that the hypotension observed was due to a specific deficiency in potassium. The possible mechanisms for this action are now under investigation.

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C-M Medium: A Mounting Medium for Small Insects, Mites, and Other Whole Mounts

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Past experience in mounting mites has shown that the existing media are not completely adequate in many respects. A mounting medium was therefore sought that would permit ease and speed in mounting and yet have a refractive index that would give better definition of the morphological and gross histological structures. Experimentation was carried out using methocellulose, and the following formula was evolved:

Methocellulose[3]	5 g
Carbowax 4,000[4]	2 "
Diethylene glycol	1 ml
95% Ethyl alcohol	25 "
Lactic acid	100 "
Distilled water	75 "

The methocellulose and alcohol are mixed, added to the remainder of the formula, and filtered through glass wool. The medium is then placed in an oven at 40°–45° C for 3–5 days, or until it has reached the desired consistency. If it becomes too thick the viscosity may be reduced by warming gently or by thinning with 95% ethyl alcohol or water.

Specimens cannot be transferred directly from glycerine, strong acids, or bases such as KOH clearing solution. It was found, however, that specimens cleared in KOH could be mounted safely if they were first rinsed in acid-alcohol.

Acarina, larval cestodes, nematodes, and insects (larvae and adults) have been mounted with excellent results. The best procedure for mounting mites was to clear thoroughly in lactophenol before mounting. At times a slight shrinkage occurs, but this can be reflected by warming the lactophenol solution and the mites slightly. Mosquito larvae mounted well by passing through cellusolve into the medium. Some of the more delicate specimens needed no special clearing procedure but were placed directly into the medium, thereby allowing the lactic acid in the medium to clear the specimen.

Some of the favorable characteristics of the C-M medium are as follows:

1. It has an excellent refractive index for arthropod tissues, namely, 1.428.
2. It is not visibly affected by light (does not turn yellow as does balsam).
3. It is heat-stable at average temperatures (slides were held at 55° C for 6 months without visible change).

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[2] The authors are grateful to Roderick Craig for his advice and many helpful suggestions.

[3] Methocel, furnished by Veronal Chemical Company.

[4] Supplied by Carbide & Carbon Chemicals Corporation.

4. It acts as a temporary ringing compound. (Although it does not replace standard ringing compounds, it forms a temporary protection for the specimen.)

5. Specimens may be mounted from xylene, toluene, water, alcohol, cellusolve, lactic acid, lactophenol, or a number of other preservatives and clearing agents, or specimens may be placed in the mounting medium alive.

6. It does not crystallize (there were no signs of crystallization after slides were held at 55° C for six months).

Enhancement of the Action of Streptomycin

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Various attempts have been made to enhance the action of streptomycin, either by combining it with other drugs such as potassium iodide (*1*) and *p*-aminosalicylic acid, (*2*, *3*) or by making a compound with *p*-aminosalicylic acid ([*4*], intracerebral method). In the present investigation we have used the rabbit and mouse corneal methods (*5*, *6*) in order to determine the activity of such combinations.

Combination of streptomycin and potassium iodide. In the first of two experiments 12 rabbits were used; 6 were infected in both eyes and 6 in the right eye only. Treatment was started on the 7th day, when all inoculated animals had developed very early lesions. In the group of 6 animals bilaterally infected, the right eyes received streptomycin and potassium iodide, and the left eyes received streptomycin only. Ten mg of streptomycin was given twice weekly, and 10 mg of potassium iodide was given thrice weekly, all by intravitreous injection. Of the 6 animals in which only the left eyes were infected 3 received thrice weekly injections of potassium iodide and the other 3 were untreated controls. Treatment was continued until the 60th day. The results are shown in Fig. 1, in which the size of the corneal lesion is plotted against time.

In the second experiment 10 rabbits were used, 8 of which were infected in both eyes and the other 2 in the right eyes only. Treatment was withheld until the 16th day, when all inoculated eyes had developed more advanced lesions, with early caseation. The treated group consisted of the 8 animals with bilateral corneal infection; the right eyes received streptomycin and potassium iodide, and the left eyes streptomycin only. The remaining 2 animals served as untreated controls. Treatment was as in the first experiment but was continued for 72 days, and the experiment was finally terminated on the 147th day. The results are shown in Fig. 2.

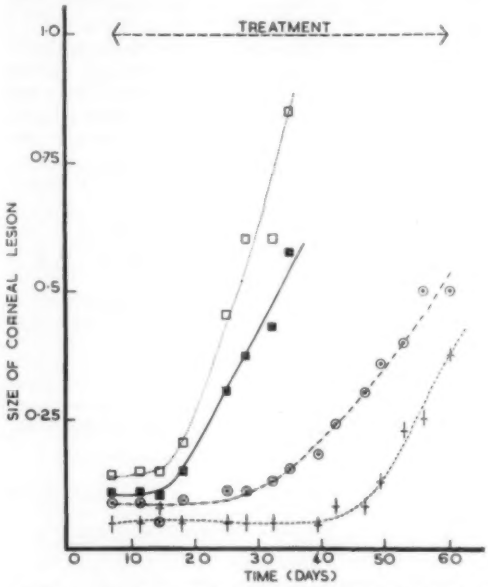

FIG. 1. Effect of combined streptomycin and potassium iodine in early tuberculous corneal lesions in rabbits.

——■—— = control group
····□···· = potassium iodide group
- - - -⊙- - - - = streptomycin group
- - - -+- - - - = streptomycin and potassium iodide group

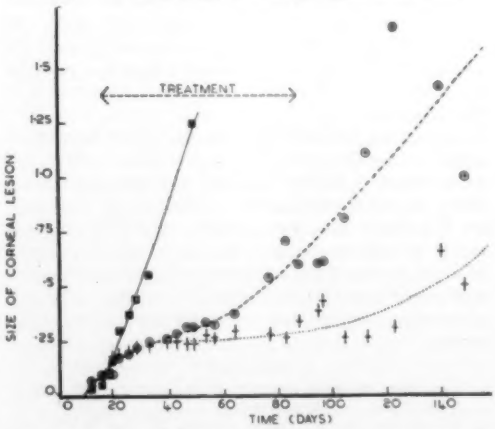

FIG. 2. Effect of combined streptomycin and potassium iodide in later tuberculous corneal lesions in rabbits. (Legends as in Fig. 1.)

[1] At present on the scientific staff of the Medical Research Council.

[2] We are grateful to the W. H. Ross Foundation (Scotland) for the Prevention of Blindness, which defrayed some of the expenses, and to the Medical Research Council for the supply of radioiodine. The streptomycin was kindly supplied by the Tuberculosis Study Section of the U. S. Public Health Service (through Dr. Schmehl), the streptomycin *p*-aminosalicylate by Chas. Pfizer & Co., Inc. (through Dr. Hobby), and the *p*-aminosalicylic acid by Herts Pharmaceuticals Limited (through Mr. Seymour).

The corneal test was used in a similar experiment with streptomycin and potassium iodide in mice in which only one eye was infected. The results were assessed both on the incubation period and on the subsequent progress of the corneal lesions. There were 6 untreated control mice, 7 mice on potassium iodide (400 mg/k of the diet), 14 mice on potassium iodide combined with streptomycin (4 mg daily subcutaneously) and 12 mice on streptomycin (4 mg daily). Treatment was started on the day of infection and maintained for 28 days (Fig. 3).

In order to compare the concentrations of potassium iodide produced in the present experiments with those used by Woody and Avery, experiments were done with radioactive iodine. Guinea pigs (as used by Woody and Avery) were given sodium iodide (containing I^{131}) by stomach tube in doses of 80 mg/k. Rabbits and mice

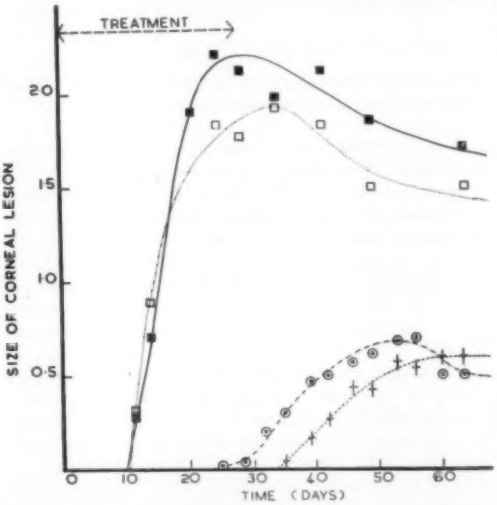

FIG. 3. Effect of combined streptomycin and potassium iodide on the development of tuberculous corneal lesions in mice. (Legends as in Fig. 1.)

were treated with I^{131} as described above. The results show that the concentrations of iodine in the guinea pig and mouse were of the same order, but that the iodine in the aqueous of the rabbit's eye was considerably higher.

Our results with combined streptomycin and potassium iodide confirm those of Woody and Avery. The enhancement of the action of streptomycin, though not marked, is most definite in established caseous tuberculosis (Experiment 2 on rabbits) and becomes more evident only after prolonged treatment. The effect in very early lesions (first experiment on rabbits and mice) is much less definite, and this probably explains the negative results recently described by Levaditi and his co-workers (*7*) in acute tuberculosis in the mouse.

An experiment on mice using a combination of potassium iodide and *p*-aminosalicylic acid (2% in the diet) showed no enhancement of the effect of *p*-aminosalicylic acid, thus confirming the work of Bavin (*8*).

Streptomycin p-aminosalicylate compound. In this experiment 33 mice were infected intracorneally and divided into four groups. Streptomycin was given in a dose of 4 mg/day and the streptomycin *p*-aminosalicylate compound in daily doses containing 4 mg of streptomycin. *p*-Aminosalicylic acid was given as 2% in the diet. The treatment was begun within a few hours of infection and maintained for 28 days. The results, as judged by prolongation of the incubation period and by the number of eyes remaining free from tuberculosis at the end of the experiment, show clearly that all three forms of treatment had produced a beneficial effect, but of the three treatments the streptomycin *p*-aminosalicylate was the least effective. Hence, even if streptomycin salicylates reduced the development of resistant strains of tubercle bacilli in man, combined streptomycin and PAS treatment definitely can (*9*), and at the same time it has greater chemotherapeutic activities.

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Use of Selective Fluorescent Stains to Detect Insect Egg Plugs on Grain Kernels[1]

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A major need in the cereal-processing industries is a method for the detection and elimination of grain which contains insects at various stages of development within the kernels. Methods yielding presumptive evidence of internal infestation have been proposed. These involve staining the gelatinous insect egg plug of the granary weevil, *Sitophilus granarius* L., and the rice weevil, *S. oryzae* L., with Lugol's solution (*1*), acid fuchsin (*1*), or gentian violet (*2*) in order to render them visible. Such procedures have not proved entirely satisfactory, since these reagents usually stain the starchy endosperm and frequently other tissues of the grain as well, and thus render difficult the adequate differentiation of infested kernels from those that are only mechanically injured. A selective stain specific for the egg plug is highly desirable.

[1] Contribution No. 187, Department of Milling Industry. This research was supported by a grant from the Millers' National Federation, Chicago, Ill.

In this laboratory it has been found that immersion of infested grain, such as wheat and corn, in aqueous solutions containing 20 ppm of the alkaloid berberine sulfate for a period of 1 min results in selective staining of the egg plug. The seed coat and other parts of the grain take up the stain in insignificant amounts; thus washing or further treatment of the seeds is unnecessary. On exposure of the treated kernels in the dark to a source of ultraviolet radiation having a predominant wavelength of 3,660 A, the stained egg plugs will fluoresce intensely in the yellow range of the spectrum and may be identified easily without auxiliary visual aids. A light-tight viewing box, with hand-holes to which are attached sleeves ending in elastic cuffs, provides for manipulation and examination of samples under the ultraviolet light in ordinary room illumination.

Other alkaloids will also produce fluorescence of the egg plug. Chelidonium extract is very selective and causes the egg plug to fluoresce orange-yellow. Primuline causes a light-blue fluorescence of the plug but also stains the seed endosperm to a considerable extent. Thioflavin is selective for the egg plug and fluoresces a light-yellow color. The fluorescent stains described are being employed in the development of quantitative methods for the determination of insect-infested kernels in grain.

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Embryonic Death Rate and Sex Ratio in Chicks

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In chicks the male is the homogametic type and should exhibit a lower embryonic death rate than the female. Hays (*1*) pointed out that with a mild disease outbreak in the parents, female embryos are more likely to succumb at an early stage of development.

During the hatching season of 1950 there was no evidence of disease in the parent stock, and chick mortality was less than 3% up to 8 wks of age. This provided an opportunity to study the relation between the percentage of fertile eggs that hatched from each of 108 Rhode Island Red females and the sex ratio of the chicks at 8 wks of age. Table 1 shows these females grouped with respect to the hatchability of their eggs and the sex ratio of their chicks.

TABLE 1

Egg hatchability of dams (%)	No. dams	Sex ratio (percentage of males) of chicks at 8 wks
60–69	8	55.31
70–79	30	52.47
80–89	34	51.69
90–100	36	49.12

These summarized data appear to suggest a linear decline in the percentage of males as hatchability increases. The slope of the line representing this decline was found to be -1.935 ± 0.272. The small magnitude of its standard error suggests a significant decline in sex ratio. These data strongly suggest that the greater portion of embryonic deaths occur in females and that the sex ratio approaches equality when few embryos die.

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Complete Elimination of Microorganisms from an Intestinal Parasite (*Ascaris lumbricoides*)[1]

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In vitro physiological investigation of the parasitic nematodes (roundworms) is hindered seriously by the presence of contaminating microorganisms, particularly in the case of nematodes inhabiting the alimentary canal of higher animals. When quantitative information is desired concerning nutrition, excretion, secretion, and respiration of such species, and the *in vitro* experimental period extends for more than a few hours, as it usually must, the elimination of microorganisms is essential (*1, 2*).

The present communication describes for the first time a method by means of which axenic[2] preparations of a common intestinal nematode may be made. This method is particularly useful in that microorganisms are eliminated completely from the parasite's intestinal tract, as well as from all other external surfaces. As a result, the nutrition and the excretion products of this species are now being studied under controlled conditions. The method of preparation is given below.

Ascaris lumbricoides adults were collected at the slaughterhouse in insulated bottles containing warm 0.9% NaCl solution, and were taken immediately to the laboratory, where decontamination methods were initiated within 2–3 hr of removal of the parasites from the pig intestine. All procedures were carried out at 37° C. with strict observance of aseptic techniques.

The worms were washed collectively with saline, and medium-sized males and females (1.5–3.0 g) were transferred to individual 125-ml Erlenmeyer flasks containing 30 ml of 0.8% nutrient broth (Bacto) at pH 6.0. This broth contained the following substances: NaCl, 0.45%; sodium sulfathiazole, 1:250; neutral acriflavine (Euflavine[3]), 1:5000; α, α′-azobis (chloroformamidine) (Azo-

[1] With financial assistance from the National Research Council of Canada and Swift & Company.

[2] The term axenic was proposed by Baker and Ferguson (*3*) to describe an organism free from all demonstrable life apart from that produced by its own protoplasm.

[3] British Drug Houses, Ltd., Toronto.

chloramide[4]) 1: 5000; dihydrostreptomycin sulfate 40 mg. The azochloramide and dihydrostreptomycin were added as dry powders to the broth solution just before it was dispensed into the flasks. The flasks, each containing a single *Ascaris*, were then placed in large vacuum desiccators (18 flasks/desiccator) containing 300 ml of freshly prepared 20% alkaline pyrogallol solution, and these were evacuated quickly to a residual pressure of 60 mm Hg. Atmospheric pressure was restored with cylinder nitrogen gas, and the process was repeated twice. The pyrogallol served to remove oxygen present as impurity (0.2%) in the nitrogen gas. Desiccators and contents were incubated in a water bath in a constant temperature room for 4 hr, after which 1 ml of penicillin solution (30,000 units) was added to each flask and anaerobic treatment continued for an additional 4 hr. The treatment solution was then drained off and replaced with 50 ml of nutrient broth containing 0.45% NaCl and adjusted to pH 7.8. The worms in this broth were incubated either aerobically or anaerobically for 36 hr.

Most flasks at the end of 36 hr showed no visible bacterial growth. Transfers (0.15 ml) were made to broth tubes for aerobic and anaerobic culture. At the same time the worms were placed in fresh broth (pH 7.0) and incubated for a further period of 24 hr, after which fresh transfers were made. Observation of flasks and transfer tubes was continued for at least 96 hr, and usually for one week or longer. Proof of sterility was taken as the continuing absence of growth from flasks and transfer tubes. Since the microorganisms dealt with were derived solely from the intestinal flora of the host (pig), culture media other than nutrient broth were unnecessary.

Repeated experiments, using 9–27 worms per experiment, showed clearly that an average of 85% of the individually treated worms could be made axenic. In a very few instances yeasts persisted in the absence of bacteria, but growth of molds and fungi was never observed. For reasons that are not understood, 8 hr *aerobic*, rather than *anaerobic*, treatment gave consistently poorer results. Continuing efforts are being made to produce a more completely efficient method.

The decontamination procedure as described has no apparent harmful effects upon the parasite. Motility and viability are unimpaired, and the intestine appears normal when examined histologically. Eggs are produced, and develop motile embryos, but no statistical comparison of egg production and development in treated and untreated females has been made.

It is hoped that this method, or a modification thereof, will prove useful when applied to other nematodes. In a single experiment we were able to prepare axenic cestodes (*Raillietina cesticillus*) in apparently unharmed condition, after 10 min aerobic exposure to the treatment solution.

[4] A generous supply of Azochloramide N.D.A. was kindly provided by Wallace and Tiernan Products, Inc., Belleville, N. J.

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Book Reviews

Physico-Chemical Constants of Pure Organic Compounds. J. Timmermans. New York: Elsevier, 1950. 693 pp. $12.50.

According to the author, "this work records, as completely as possible, those physico-chemical constants of organic compounds which have been measured with sufficient care to warrant their acceptance as data established with a precision worthy of contemporary science." The criteria which qualify a substance by its purity, and a constant by its exactness for acceptance are stated in the initial pages of the volume. Necessarily, both go together, and the principles followed by the author in the selection make highly instructive reading for anyone interested in the problems that arise when compounds are purified and constants are measured in accordance with rigorous standards. These few pages are followed by more than 600 pages of tables which give a critical selection of the constants of more than 1,600 substances. The compounds are arranged according to a lucid chemical system, and their location in the tables is further facilitated by an empirical formula index and by a subject index. A bibliography completes the book.

It cannot be the objective of this review to analyze in detail the tables of constants. For each individual compound are given the preparative data relating to purity, and the constants listed include critical constants, vapor pressure, boiling point, freezing point, density, specific heat, latent heats, viscosity, surface tension, refractive indices, and other data like heat of combustion, critical density, etc., depending on the available values. Where more than one independent measurement qualifies for listing, the results of each are given.

Anyone who has faced the job of finding in the literature the most reliable physical constants for the most highly pure compounds will be grateful to the author for the stupendous task he has accomplished. The work is one of the fruits of a quarter-century's activity of the International Bureau of Physico-Chemical Standards, of which the author is director. It combines the results obtained in the laboratories of this institution with the data provided by a systematic survey of the literature by a man who is familiar with the intricacies of pure compounds and of exact measurements. This has been accomplished with the support of the Belgian Chemical Industry and the Belgian National Fund for Scientific Research. The user of the book will benefit from the

author's devotion to pure compounds and from his passion for exactness. The work is a monument to the patience and perseverance of a scientist who devoted his labors to the purification of compounds and to the measurement of exact constants, and whose attitude is set forth in the statement on page 9, "for the truth alone is unique, while error is manifold."

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The Clinical Use of Radioactive Isotopes. Bertram V. A. Low-Beer. Springfield, Ill.: Charles C Thomas, 1950. 414 pp. $9.50.

Some of the clinical medical applications of radioactive isotopes have now pervaded the fields of endocrinology, surgery, clinical physiology, dermatology, gynecology, and many other medical specialties in addition to radiology and biochemical research. The effort required to understand the background of atomic physics and to appreciate the potential applications of radioactive materials to specific medical problems has been a forbidding prospect for most physicians. This volume is an admirable attempt to correlate necessary information, and the book presents it in quite readable form.

The discussion of radiation physics in nonmathematical language occupies the first part of the book, and the basic essentials of atomic structure and the properties of radioactive atoms are logically covered without unnecessary detail. Those who anticipate considerable work with isotopic materials will need to consult the more complete reference sources given at the end of this part, but a surprisingly complete scope of the subject is made available here. In addition, there are excellent chapters on equipment and the units used in detection and measurement, as well as notes on the handling and disposal of radioactive materials.

The clinical applications are covered in the second part of the volume, which is divided into sections on diagnostic investigations, dosage determinations, and therapeutic applications. The nature of the uses that have been found for isotopes is responsible for what seems to be a succession of unrelated subjects as individual isotopes are discussed. This section will also most quickly become obsolete, for many of the clinical uses are in exploratory stages, but the situation is fairly evaluated up to the publication date. Furthermore, the principles here discussed will remain valid for later changes in method, and the preliminary section on physics ensures that the reader will have the requisite basic information to apply his understanding to new fields.

It is appropriate that emphasis should be placed on the physiological data accompanying isotopic distribution in the body, and that specific dosages and clinical techniques are largely confined to those isotopes that have already shown reasonably permanent worth, particularly radioactive phosphorus and iodine.

The volume is suitable for use as a text for students whose work will include use of isotopes in clinical research or therapy, and it should be required reading for radiologists, radiological physicists, and physiologically minded physicians. It will be a valuable reference work for physicians in almost every medical field.

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Biology of Drosophila. M. Demerec, Ed. New York: Wiley; London: Chapman & Hall, 1950. 632 pp. $10.00.

This book, some ten years in the making, represents primarily reports of original research by the authors on aspects of the biology of *Drosophila*. Under the editorship of M. Demerec, the authors, Kenneth W. Cooper, B. P. Sonnenblick, D. F. Poulson, Dietrich Bodenstein, G. F. Ferris, Albert Miller, and Warren P. Spencer, have contributed chapters on normal spermatogenesis, early embryology, histogenesis, organogenesis, and differentiation in the embryo, on postembryonic development, external morphology, internal anatomy and histology, and on collection and laboratory culture, respectively. The emphasis is on *Drosophila melanogaster*, with pertinent information on other species of the genus and on related organisms. The numerous photographs and drawings are with few exceptions original. A deliberate restriction to discussion of the wild type form serves to keep the volume from becoming unwieldy, although the apparent necessity of avoiding discussion of the pertinent information on mutant types is regretted by this reviewer —as is the almost total absence of reference to *Drosophila* physiology.

In any work of this magnitude, there are bound to be statements which to some readers seem equivocal. For example, in the chapter on postembryonic development, Bodenstein, in describing the venation of the prepupal wing, states (p. 297) that "they are apparently not identical with the later imaginal veins (Waddington, 1939)." Waddington, *loc. cit.* (*Proc. Nat. Acad. Sci.*, 25, 299), actually states that "This venation is not *altogether* [reviewer's italics] identical with that of the adult; ...." In view of the possibility that the prepupal venation may be in part homologous with the wing venation of subsequent stages, Bodenstein's citation would seem to this reviewer to be misleading. (It should be added that there is no reference to Waddington's more extensive description of wing development in the *Journal of Genetics*, 41, [1941].)

To the *Drosophila* worker, long plagued by the scattered and fragmentary nature of the literature on the biology in *Drosophila*, this book should prove to be an invaluable reference manual.

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News and Notes

Golden Jubilee Celebration of the Genetics Society of America

W. Ralph Singleton

Brookhaven National Laboratory, Upton, Long Island, New York

The Genetics Society of America celebrated the Golden Jubilee of the rediscovery of Mendel's law at the nineteenth annual meeting, held September 11–14 at The Ohio State University in Columbus. In 1900, three separate investigators, De Vries in Holland, Correns in Germany, and Tschermak in Austria, announced their discovery of Mendel's earlier work. With these three independent investigations the modern science of genetics began.

The meeting was held under the sponsorship of the American Institute of Biological Sciences. C. J. Hylander, Executive Secretary of the American Institute of Biological Sciences, and his staff, in cooperation with the local committee, on which D. C. Rife was the Genetics Society representative, made arrangements for the general meeting, and R. G. Jap worked with Dr. Rife in making preparations for the activities of the society. The program covered four days, with all short papers and demonstrations concentrated into the first day. Seventy-two short papers and 10 demonstrations were given in three concurrent sessions, so that all authors who were present had a brief opportunity to present the results of their individual research. A luncheon in Baker Hall, attended by a record-breaking crowd of 313, was followed by the society's business meeting, at which President Curt Stern presided. The newly elected officers are M. R. Irwin, president, J. W. Gowen, vice president, and Ernst Caspari, treasurer.

The Golden Jubilee Celebration began Monday night with a meeting jointly sponsored by the Genetics Society and the AIBS. Frank P. Cullinan, chairman of AIBS, presided. R. E. Cleland responded to the address of welcome by H. L. Bevis, president of the Ohio State University, and Curt Stern expressed the thanks of the society to the Golden Jubilee Committee that planned the celebration. The committee consisted of L. C. Dunn and M. R. Irwin, co-chairmen, and C. L. Huskins, I. M. Lerner, and P. C. Mangelsdorf. Dr. Stern then introduced the speaker of the evening, Richard Goldschmidt, professor emeritus of the University of California. Dr. Goldschmidt spoke on "The Impact of Genetics on Science," relating how genetics in its short life span of 50 years had had a remarkable effect on almost every branch of science, especially the biological sciences. The essence of his remarks is well summed up in an article, "Fifty Years of Genetics," published in the September–October issue of the *American Naturalist*, which was originally prepared to be read at the opening of the Golden Jubilee meeting. When Dr. Goldschmidt learned that he was to address the members of all the biological societies meeting at Columbia, he substituted a more general paper.

The unusually high plane on which the meeting was initiated by Dr. Goldschmidt continued throughout the rest of the three-day invitation program. In a brief report it is not possible to comment on all the talks given or to touch all the high lights of the program. One of the most interesting papers was that by W. E. Castle, "The Coming of Mendelism." Dr. Castle was one of the few who not only witnessed the coming of Mendelism but at a very early stage took an active part in genetic research, which he has continued to the present time, several years after his retirement from Harvard University. Another significant paper, entitled "The Heritage of Mendel," was prepared by Hugo Iltis who, unfortunately, was unable to attend. His paper was read by G. H. Shull, a long-time friend, and one of the first from this country to visit Brünn after the rediscovery of Mendel's work. In a ceremony entitled "The New World Honors Mendel," Manuel Elgueta, director of the Inter-American Institute of Agricultural Sciences, at Turrialba, Costa Rica, presented a scroll, appropriately engrossed, to the Genetics Society of America. This scroll will be placed in the Mendel Museum established by Dr. Iltis at Mary Washington College in Fredericksburg, Va. A part of the museum collection, on loan to the Ohio State University, was on exhibition at the time of the meeting.

The main theme of the Golden Jubilee Program was the progress genetics has made in its first fifty years. Five eminent European geneticists, T. Caspersson, Boris Ephrussi, C. D. Darlington, Arne Muntzing, and Julian Huxley, were speakers, contributing markedly to the success of the meeting. All the papers given on the invitation programs will be published early in 1951 by the Macmillan Company as a book, the scope and organization of which are revealed in the following summary:

HISTORICAL AND DEVELOPMENTAL ASPECTS OF GENETICS

- The Status of Heredity before 1900—Conway Zirkle, University of Pennsylvania
- The Coming of Mendelism—W. E. Castle, University of California
- The Development of the Gene Theory—H. J. Muller, Indiana University
- The Relation of Genes and Chromosomes—A. H. Sturtevant, California Institute of Technology
- Mutation after Fifty Years—L. J. Stadler, University of Missouri

The Heritage of Mendel—Hugo Iltis, Mary Washington College

Old and New Pathways in Human Genetics—L. H. Snyder, University of Oklahoma

THE PHYSICAL BASIS OF THE GENE

- The Chemistry of Chromosomes and Nuclei—A. E. Mirsky, Rockefeller Institute for Medical Research
- Cytochemical Measurements in the Study of the Gene—T. Caspersson and Jack Schultz, Karolinska Institute, Stockholm

Genetics and Immunology—M. R. Irwin, University of Wisconsin

THE PHYSIOLOGY OF THE GENE

Chemical Genetics—G. W. Beadle, California Institute of Technology

Remarks on Cell Heredity—Boris Ephrussi, University of Paris

Genetic Studies in Bacteria—Joshua Lederberg, University of Wisconsin

The Role of the Genes in Cytoplasmic Inheritance—T. M. Sonneborn, Indiana University

Evolutionary Changes in Mendelian Populations—Th. Dobzhansky, Columbia University

CYTOGENETICS

Evolution of Cytogenetic Mechanisms in Animals—M. J. D. White, University of Texas

Genetics and the Chromosomes—C. D. Darlington, John Innes Horticultural Institute

GENETICS, MEDICINE, AND MAN

Genetics and Disease Resistance—J. W. Gowen, Iowa State College

Genetics and the Cancer Problem—C. C. Little, Roscoe B. Jackson Memorial Laboratory

GENETICS AND THE FOOD PROBLEM

Genetics and Plant Breeding—Arne Muntzing, University of Lund

Hybrid Corn: Its Genetic Basis and its Significance in Human Affairs—P. C. Mangelsdorf, Harvard University

Genetics and Plant Pathology—J. C. Walker, University of Wisconsin

Genetics and Animal Breeding—J. L. Lush, Iowa State College

Genetics and Modern Thought—Julian Huxley, formerly Secretary-General UNESCO

The Golden Jubilee, the largest meeting ever held by the Genetics Society, was one of the most enjoyable, partly in consequence of the excellent physical facilities assigned to the society by AIBS and the local committee. Except for the first evening gathering, all lectures were held in the new auditorium of the State Archaeological Museum, with a seating capacity of 600, which was expanded to about 900 by making use of the wide foyers. The Genetics Society is happy that this particular auditorium was allocated to us on this important occasion, and thanks are due the Ohio State Archaeological Museum, the staff of AIBS, and the local committee for their careful planning. In cooperation with the Public Affairs Committee, the society has issued a pamphlet (No. 165) entitled *Genetics—The Science of Heredity.* Written by John Pfeiffer and illustrated by Ralph Graeter, this 32-page article lays the subject of genetics understandingly before the public and is a fitting summation and consummation of a Golden Jubilee.

Botanical Society Meeting

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At its 45th annual meeting, held at Ohio State University September 11–13, The Botanical Society of America, Inc., joined with the Genetics Society of America in celebrating the 50th anniversary of the rediscovery of Mendel's research. About 220 research papers were presented before more than 400 members attending this first fall meeting.

Katherine Esau, associate professor of botany and associate botanist of the College of Agriculture of the University of California, was elected president for 1951, and the incoming vice president is W. H. Camp, curator of experimental botany, Academy of Natural Sciences, Philadelphia. The society also elected the following scientists to corresponding membership: F. Børgesen and P. Boysen Jensen, Copenhagen; F. E. Fritch, London; Ernst Gäumann, Zurich; Brother Leon, C. S. C., Havana; Carl Skottsberg, Stockholm; and Otto Warburg, Berlin.

It was decided to ask the American Institute of Biological Sciences to arrange for the 1951 meeting at the University of Minnesota and for the 1952 and '53 meetings on other university campuses.

Autumn Meeting of the American Physiological Society

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The third autumn meeting of the American Physiological Society was held on the campus of Ohio State University at Columbus, September 14–16. There were 462 registrants at the meeting, and about 300 of these were housed in dormitories on the campus. Two hundred and forty scientific communications were presented at scientific sessions held all day Thursday and Friday and Saturday mornings. Five or six sectional meetings were held simultaneously. Demonstrations and movies were held Friday afternoon, followed by a business meeting at 4:30.

Informal entertainment for those attending the meeting was held on the campus Thursday evening. This consisted of a musical program presented by the Independent Players of Columbus and was followed by a social hour. Friday evening the annual banquet of the society was held in the ballroom of the Neil House. More than 275 persons attended. Following the banquet the address of the retiring president was delivered by Carl Wiggers, of Western Reserve University. On the Wednesday before the meeting there was a field trip to Wright-Patterson Air Force Base. About 40 persons went on this trip, which included a tour of the entire field.

At a meeting of the council of the society which preceded the scientific sessions, the succession of D. B. Dill, scientific director of the Army Chemical Center and president-elect of the society, to the presidency was confirmed. In this way the vacancy created by the death of the society's president, H. C. Bazett, was filled. This is the first time in the history of the American Physiological Society that the president has died in office.

Scientists in the News

The American Chemical Society has chosen **Edgar C. Britton** its president-elect. He is director of the organic research laboratory of the Dow Chemical Company and a leader in the development of insecticides, weed killers, and pharmaceuticals. **N. Howell Furman**, Russell Wellman Moore professor of chemistry at Princeton University, will be president for 1951, the society's diamond jubilee year. **Arthur C. Cope**, chairman of the Chemistry Department, MIT, and **W. Conard Fernelius**, head of the Chemistry Department, Pennsylvania State College, have been elected directors.

George B. Cressey, president of the International Geographical Union, left recently for Hong Kong. En route he plans to visit a number of the National Committees of the Union in Europe and southern Asia. He will remain in Hong Kong for several months in connection with a Social Science Research Council travel grant.

Z. P. Metcalf, former head of the Department of Zoology and Entomology at North Carolina State College, Raleigh, a division of the Consolidated University of North Carolina, has retired. He will remain at the college in his old quarters. Here, with assistants and a library, the greatest collection of reprints on Homoptera known, and about 100,000 specimens of the order, he will continue his studies in the taxonomy and the cataloging of Homoptera.

Formerly a research assistant in the Physics Department of the University of Texas, **John M. Walsh** has recently joined the staff of the Los Alamos Scientific Laboratory. He will work in the laboratory's GMX Division.

Lewis G. Weeks, research geologist of the Standard Oil Company (New Jersey), New York City, gave a series of 34 talks to geological societies and universities on a recent country-wide tour arranged by the Distinguished Lecture Committee of the American Association of Petroleum Geologists. His main subject was "Sedimentary Basin Development and its Bearing on Oil Occurrence." In his talk the speaker examined those broad features of the earth's crustal framework which basically determine the genesis, history, and resulting type of basin. Against this background he described and illustrated the evolution of the types of basins, and the basic conditions of architecture, sedimentation, and environment within the deposition basin, that control the incidence of oil occurrence. The following groups were addressed by Mr. Weeks:

Pittsburgh Geological Society; Indiana-Kentucky Geological Society; Mississippi Geological Society; New Orleans Geological Society; Shreveport Geological Society; South Louisiana Geological Society; Houston Geological Society; Corpus Christi Geological Society; South Texas Geological Society; Dallas Geological Society; Fort Worth Geological Society; Abilene Geological Society; West Texas Geological Society; Panhandle Geological Society; North Texas Geological Society; Oklahoma University, Geology Department; Oklahoma City Geological Society; Kansas Geological Society; University of Kansas; Tulsa Geological Society; Rocky Mountain Association of Geologists, A.A.P.G. Pacific Section; San Joaquin Valley Geological Society; Intermountain Association of Petroleum Geologists; Wyoming Geological Association; State University of Iowa; Illinois Geological Survey and University of Illinois; University of Wisconsin; Michigan Geological Survey and University of Michigan; University of Toronto; and the A.A.P.G. Eastern Section.

Grants and Awards

A board consisting of the president of eight engineering societies in the United Kingdom has awarded the **Kelvin Medal** to Theodore von Karman. Dr. Karman is chairman of the Scientific Advisory Board of the U. S. Air Force and an honorary professor of mechanical engineering at Columbia.

Three grants totaling $61,077 have been awarded to the **New York University-Bellevue Medical Center** by the National Foundation for Infantile Paralysis. One for $25,275 will make possible continuation of the search for a chemical agent that may alter or interfere with infection, an $18,900 grant will provide for concentration on the development of a rapid diagnostic method, and one for $16,902 will make possible the continuation of a reference center for information on aids and appliances or rehabilitation.

AAAS Research Grants have been awarded by: the British Columbia Academy of Science to G. A. Setterfield, University of British Columbia; the Indiana Academy of Science to Winona Welch, DePauw University; the Louisiana Academy of Sciences to C. A. Hickcox, Centenary College; the Oregon Academy of Science to J. Arnold Shotwell, University of Oregon, and Vincent D. Roth, Oregon State College; the Pennsylvania Academy of Science to Donald Shay, University of Maryland; and by the Tennessee Academy of Science to Wilson M. Whaley, University of Tennessee, and to H. B. Crouch and Joseph Rucker, Tennessee Agricultural and Industrial State College.

Fellowships

The Lalor Foundation has discontinued its one-year postdoctoral fellowships, but is continuing, on an expanded basis, its awards for summer fellowships at the Marine Biological Laboratory, Woods Hole, for advanced research in physiological chemistry, biochemistry, and biophysics. The foundation is also underwriting a series of predoctoral fellowships in the natural sciences, with emphasis on biochemical and biophysical aspects, at Harvard, Johns Hopkins, and the Universities of Delaware and Pennsylvania. Inquiries concerning the fellowships at the Marine Biological Laboratory should be sent to Philip B. Armstrong, Director. Information about fellowships at the other institutions may be obtained from the chairman of the department concerned.

Lehigh University has established the **J. D. Berg Scholarship Fund**, with an annual award of $1000 to an engineering undergraduate. The fund was a gift of Mrs. John D. Berg, in memory of her late husband, who was chairman of the Dravo Corporation and corporate trustee of the university. The scholarship will be in force for the period

of the student's undergraduate residence at Lehigh, and preference will be given to students residing in western Pennsylvania who enroll in an engineering curriculum.

The Institute of Gas Technology is offering 15 fellowships leading to both master's and doctor's degrees in gas technology. The fellowships provide an award of $1,250 and tuition for the first two years. The fellows are employed during the summer by a sponsoring company. Applications may be made by seniors and graduates in chemistry, chemical engineering, mechanical engineering, petroleum engineering, and related fields. All applications and requests for information should be addressed to The Director, Institute of Gas Technology, Chicago 16.

The Sinclair Refining Company is establishing four new fellowships that will provide $2,500 a year, and will be awarded to outstanding graduate students. Fellowships in the field of organic chemistry at the University of Chicago will be under the supervision of F. H. Westheimer, and at the University of Illinois under N. J. Leonard. A Sinclair fellowship in petroleum geology will be supervised by F. M. Van Tuyl, of the Colorado School of Mines, and Alfred Chatenever, of the University of Oklahoma, will direct research in the field of petroleum production engineering.

The Pediatric Cardiology Department of the Children's Division of Cook County Hospital, Chicago, is accepting applications for fellowships for immediate appointment. The department offers material on both congenital and acquired diseases of the heart and a complete department of angiocardiography and catheterization. Information may be obtained from Dr. Rowine H. Brown, Assistant Medical Superintendent, Children's Division, Cook County Hospital, 700 S. Wood St., Chicago.

Outstanding work in methodology research in the public health field will receive annual recognition, beginning next year, in the form of a $500 award and a plaque. The prize, to be known as the **Kimble Glass Methodology Research Award**, is to be given by the Conference of State and Provincial Public Health Laboratory Directors and is endowed by Kimble Glass, a division of Owens-Illinois Glass Company.

Deaths

James Llewellyn Crenshaw, professor of physical chemistry and head of the department at Bryn Mawr College, died November 22, at Salisbury, N. C. He was 63. Dr. Crenshaw had been associated with Bryn Mawr since 1915.

Dorothy A. Hahn, professor emeritus of chemistry at Mount Holyoke College, died December 10 at 74 after a long illness. Miss Hahn taught at Pennsylvania College for Women for seven years before joining the Mount Holyoke faculty in 1906. She retired in June 1941, after having been a member of the department for 33 years. She did research on derivatives of hydantoins, usually in collaboration with her students. She was the author of a *Dictionary of Chemical Solubilities* (with A. M. Comey), and translated and enlarged the fourth edition of *Theories of Organic Chemistry*, by F. Henrich, published with T. B. Johnson.

George J. Heuer, professor emeritus of surgery at Cornell University Medical College and former chief surgeon of New York Hospital, died recently of a heart ailment at 68.

The head of the Psychology Department at Pratt Institute, **Miriam C. Pritchard**, died recently at 44. Dr. Pritchard, who had been associated with the late Leta S. Hollingworth in research studies on the problems of gifted children, wrote several books and articles on the subject. She was on the faculty of the School of Oral and Dental Surgery of the College of Physicians and Surgeons, Columbia University.

Leland Bradley Snoddy, professor of physics, University of Virginia, died November 12 at 52. He had been a member of the faculty since 1933.

James Harvey Spencer, a retired U. S. Weather Bureau meteorologist, died December 13 at 80. A cofounder of Rotary International, Mr. Spencer was known as the poet laureate of that organization. He had written several books of poetry and prose.

Publications Received

Agricultural Periodicals of the British Isles, 1681–1900, and their Location. F. A. Buttress. University of Cambridge School of Agriculture, Cambridge, England. 2s.

Currents in Nutrition. Bertha Burke *et al.* Nutrition Monograph Series, No. 1. National Vitamin Foundation, Inc., 150 Broadway, New York City.

Oriental Botany. Catalog No. J-1 of Books, Serials and Periodicals. Charles E. Tuttle Company, Rutland, Vt.

Research and its Organization. Ellice McDonald. Biochemical Research Foundation, Newark, Del.

Field Trials II: The Analysis of Covariance. Commonwealth Bureau of Plant Breeding and Genetics, Tech. Comm. No. 15. School of Agriculture, Cambridge, England. 3s. 6d.

Pacific Science Board: Third Annual Report, 1949. National Research Council, 2101 Constitution Avenue, Washington, D. C.

Conservation in the Americas. Annette L. Flugger, Ed. Pan American Union, Washington, D. C.

Measurement of Low Temperatures. Physics Department, Westinghouse Research Laboratories, E. Pittsburgh, Pa.

Stone Age Cultures of Northern Rhodesia. J. Desmond Clark. South African Archaeological Society, Box 31, Claremont, Cape, South Africa. 21 s.

Vertebrate Faunas of the Lower Old Red Sandstone of the Welsh Borders and **Petraspis Leathensis *White: A Dittonian Zone-fossil.*** Errol Ivor White. Vol. 1, No. 3. Bull. British Museum (Natural History), London. 7s. 6d.

Science and Foreign Relations. Publ. 3860, Department of State. Division of Publications, Office of Public Affairs, Washington 25, D. C.

Liquid Metals Handbook. AEC, ONR, and Navy Bur. Ships. U. S. GPO, Washington 25, D. C. $1.25.

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THE INVERTEBRATES: Volume III. Acanthocephala, Aeschelminthes, and Entoprocta
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By LIBBIE H. HYMAN, American Museum of Natural History, New York. *McGraw-Hill Publications in the Zoological Sciences.*

These two additional volumes of Dr. Hyman's monumental reference work offer a complete, detailed, and modernized account of the anatomy, embryology, ecology, and physiology of the groups included. Not intended as texts, these volumes are rather treatises for the advanced student and teacher of zoology. The author has purposefully avoided the type plan of arrangement, and the presentation if for groups in general, rather than for the particular species. Both volumes are essentially a compilation from the literature on the subject; however, a considerable amount of original material is included.

INTRODUCTION TO STATISTICAL ANALYSIS

By WILFRID J. DIXON and FRANK J. MASSEY, JR. University of Oregon. In press

The basic purpose of this text is to present a first course in statistics requiring only a minimum of mathematics. Both classical and modern techniques are presented with emphasis placed on the understanding and application of these techniques rather than on mathematical development.

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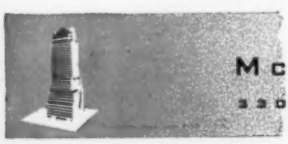

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